the LINK

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

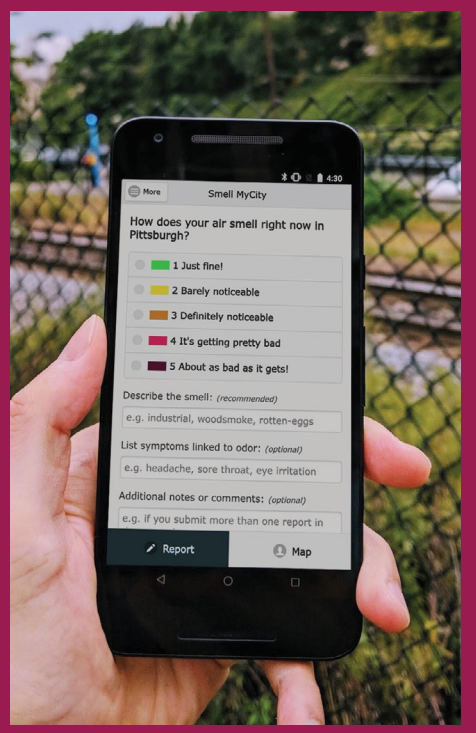
SHERRI NICHOLS

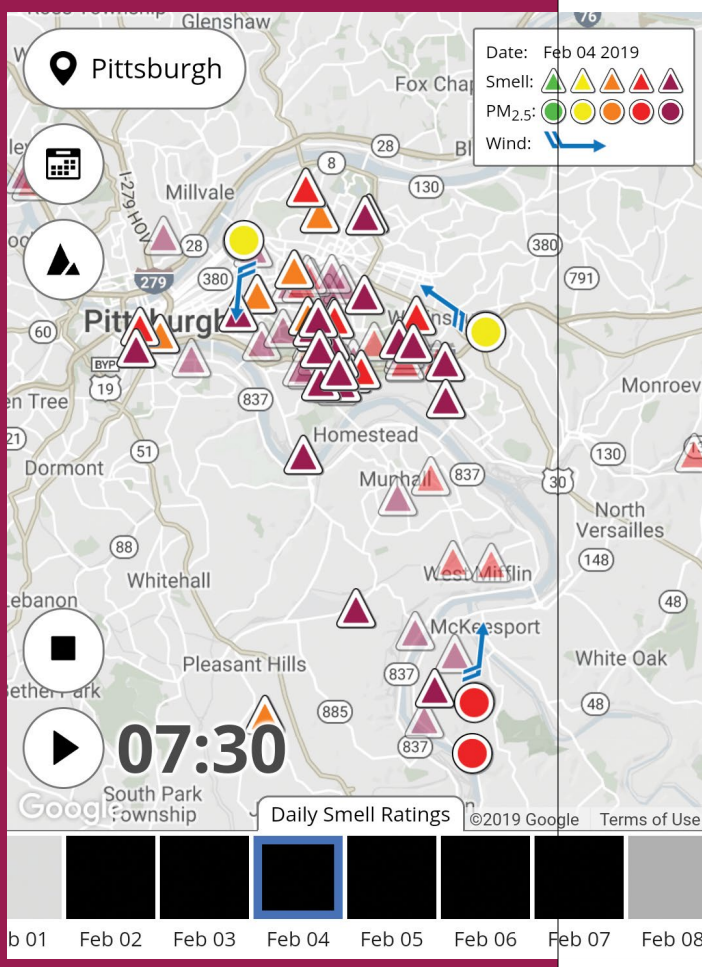
Godmother of Sabermetrics

SUMMER 2019
ISSUE 13.1

theLINK

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.





City Smelling App Catching On

Smell PGH, the smartphone app developed by Carnegie Mellon University's CREATE Lab that helps Pittsburghers report foul odors to health authorities, is going national with the help of Seventh Generation, an environmentally conscious household and personal care products company.

The Smell MyCity app premiered in Louisville, Kentucky, with plans to do the same in Portland, Oregon, later this year. The free app is available from Apple's App Store and Google Play.

The idea is that if the air smells bad, there's a good chance it's not healthy to breathe. By reporting stinky air via the app, users can alert local health authorities while collectively tracking its spread across a community, helping to pinpoint its origins. In Pittsburgh, where the app has been used since 2016, smell reports are forwarded immediately to the Allegheny County Health Department.

Last year, the CREATE Lab expanded its Breathe Cam network of cameras — which provide 24-hour monitoring of visible air pollution in Pittsburgh — to include several industrial sources in the Monongahela Valley, based on a history of citizen reports via Smell PGH. The Heinz Endowments sponsored the development of Smell PGH and Smell MyCity, and also underwrites Breathe Cam.

Any community in the U.S. now can use the Smell MyCity app to document and monitor pollution odors in their neighborhoods. Community-sourced smell report data can be easily accessed through the Smell MyCity website. With the support of Seventh Generation, CMU's CREATE Lab is exploring additional partnerships with grassroots organizations across the country to ensure that local smell report data shared in the app is sent to the appropriate local regulatory agencies and decision-makers.

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contents

It's Been Fun

When you're the interim dean of a place like Carnegie Mellon University's School of Computer Science, everyone asks you, "What's it like to be interim dean?" The true answer? It's fun! It forces you to learn new things every day, whether it's about fundraising, undergraduate admissions or how many staff members it truly takes to keep the college running smoothly. In fact, I view my job as mostly creating an easy transition for the new dean.

That doesn't mean I've been sitting around twiddling my thumbs since last semester, though.

At the beginning of my term, I set definite expectations for my tenure. Six months isn't much time and you have to be realistic about what you can accomplish, but SCS has certainly moved the needle in a few key areas. Since the fall, we've begun exploring ways to work with industry to jointly recruit faculty members, and we're expanding our presence in Washington, D.C., to influence public policy in areas like AI, jobs, manufacturing, privacy and security. We've started looking at how SCS can collaborate more with groups across campus on key artificial intelligence problems. AI will undoubtedly change the face of business in the next decade, for example, and a joint effort between SCS and the Tepper School of Business could help ensure that CMU is an innovator in this area.

"What's it like to be interim dean? The true answer? It's fun!"

While I've been putting my own plans into motion, SCS has continued to do the things it does best: educate the brightest students and perform research that has a direct, immediate impact on the world. You'll see evidence of that in all the stories in this issue, including how our work in AI has helped police identify and arrest human traffickers, and the ways we're using data to visualize how a range of factors have affected our planet. I'm also incredibly proud of our work reaching out to students who are underrepresented in computer science, an initiative you'll read more about in a piece on the Research Experience for Undergrads — Software Engineering program.

As I prepare to retire my temporary title and pass control of this incredible place to its next dean, I'll leave you with one of the biggest lessons I've learned this year: almost everything that happens in SCS results from its people — people who come up with brilliant ideas, do the work and do it well. All the good stuff you'll read about in this issue isn't the result of the dean. It's the result of smart folks with good ideas doing phenomenal work. Frankly, I'm not sure they really needed me.

But it was fun.

Tom Mitchell
Interim Dean
School of Computer Science

EARTHTIME

Savvy Use of Data, Technology Tells the Planet's Story

Byron Spice

Participants of the World Economic Forum in Davos, Switzerland, watch EarthTime tell the story of our planet's evolution.

THE STORY OF EARTHTIME BEGINS ON MARS.

EarthTime today is a technological platform that helps people comprehend massive amounts of data about our planet and come to grips with our biggest global challenges. But 15 years ago, people just wanted to see what the Red Planet looked like.

When NASA's Spirit and Opportunity rovers landed on Mars in 2004, they began sending back mesmerizing photos of the bleak landscape. Each of the panoramic images actually was composed of many smaller images, which were electronically stitched together to create a sweeping vista.

NASA, Google and Carnegie Mellon University's CREATE Lab in 2006 would adapt this technique for a system they called GigaPan, which made it possible for any earthling to combine multiple digital images to create detailed panoramas. And in 2011, the CREATE Lab took it a step further by enabling the visual exploration of both space and time, establishing the skeleton of what would eventually be called EarthTime.

> "EarthTime is a narrative technique for changing the way people think about the Earth and the people on the Earth." — Illah Nourbakhsh, K&L Gates Professor of Ethics and Computational Technologies and director of the Robotics Institute's CREATE Lab

At the time, they called it GigaPan Time Machine. The initial emphasis was on photographic and video imagery, but within a year they added a data set that would lead to conceptual change in the platform's evolution.

"We started with a very simple dataset that also turns out to be extremely explanatory," said Randy Sargent, initially a computer scientist at NASA Ames Research Center who split time with CMU and Google during the system's development and is now a senior systems scientist with the CREATE Lab. "We started with all of the Landsat images from the beginning of [NASA's] Landsat program, so we could go back to 1984 and show how the surface of the planet had changed.

"It shows the changes in cities, the birth of cities. It shows flooding. It shows things like deforestation. It shows the incredible expansion of agriculture. There's just so many things you get from that data set. And that was the one that kind of brought all of the other data sets together."

Now, project leaders no longer focus just on the technology, but also on the process of gathering geolocated data and finding ways to use the data to tell stories.

"EarthTime is a narrative technique for changing the way people think about the Earth and the people on the Earth," said Illah Nourbakhsh, the K&L Gates Professor of Ethics and Computational Technologies and director of the Robotics Institute's CREATE Lab.

That has meant reaching out to more than 800 researchers and datakeepers around the globe — sources such as the United Nations, U.S. Geological Survey and the London School of Health and Tropical Disease. To maintain EarthTime as an authoritative and neutral source of facts, all of this data must be peer-reviewed and defensible and, of course, must be publicly available.

"It starts with a shake of a hand with somebody who directs that organization, who agrees that they're going to give us data to make the world a better place," Nourbakhsh said.

Data is not only stored in different places, but is also available in different formats — online databases, Google tables and Excel worksheets. So the CREATE Lab has created a special file system that can digest the data in a form that can be shared through a regular web browser.

> "I like to think of our team as 21st century blacksmiths. We provide the tool that helps the most influential people in the world to make decisions that will impact the future of society and the future of our planet."
>
> — Illah Nourbakhsh

(l. to r.) Randy Sargent, Paul Dille, Illah Nourbakhsh and Gabriel O'Donnell of CMU's CREATE Lab.

"Almost everyone who gives us data has a hard time looking at their own data, ironically," Nourbakhsh said. "Once they give it to us and we digest it, we use Carnegie Mellon servers to make that data available to anybody anywhere through a web browser. And that means even those organizations that have given us the data can benefit."

The project scientists also work with topic experts who can provide crucial context for understanding the data and use the data to create meaningful stories. All of the data is geolocated so it can be superimposed on a map, but researchers also must find visual tropes that are appropriate for displaying it. Using existing tropes, such as bubbles or dots or color, some data sets can be processed into EarthTime in a matter of days. If new tropes are required, such as a GPS coordinate for every oil tanker on Earth over time, the process can take weeks or months.

"I hope that in three or four years, the process of ingesting data is near automatic," said Gabriel O'Donnell, principal research programmer. "Anybody or any researcher that has a dataset that is complementary to the platform could ingest it without our help."

In the early years, researchers needed to hand out copies of their work on hard drives. But last Earth Day, working with the World Economic Forum, the CREATE Lab launched EarthTime as a website, making the tool and its massive database broadly available.

"The EarthTime system we invented necessarily had to deal with hundreds of data layers and trillions of data points at a level that nobody needed to solve before," Nourbakhsh said. That required technological innovation in machine learning, graphic design, computer vision and human-computer interaction typified by Carnegie Mellon.

"One of the things we're working the hardest on now is the ability for more and more people to author their own stories using the datasets we've brought together," Sargent said. That means reaching out to and training journalists, educators, stakeholder organizations, corporations and even community activists.

"If a housing activist group needs to explain what's happening in a particular neighborhood," Sargent said, "we'd love to have them use this tool." ■

EarthTime has become a staple of the World Economic Forum in Davos, Switzerland.

EarthTime Tells Stories at Davos in Unprecedented Ways

Jason Maderer

Illah Nourbakhsh remembers the first time he spoke at the World Economic Forum in Davos, Switzerland. It was 2014, and the topic was the ethics of artificial intelligence.

After his talk, Nourbakhsh approached a forum organizer and mentioned that Carnegie Mellon's CREATE Lab had developed a tool called Earth Timelapse. He wondered if the technology, which created interactive images of the world, might be useful at the forum to show global trends over time. After all, Davos annually gathers the foremost thought-leaders in government, education, technology, business and the arts to shape global, regional and industrial agendas.

He was asked to bring the tool to the forum's annual meeting in China — Annual Meeting of the New Champions — but only as an experiment. "They told me, 'this technology is really cool, but things only happen once here because we need to keep things fresh and new every year,'" Nourbakhsh recalled. "We were supposed to be one-and-done."

They were anything but one-and-done. Earth Timelapse mesmerized attendees, taking massive datasets and visualizing them in ways never seen before. Attendees could zoom in on countries to see the effects of deforestation over a 20-year timespan. They could watch as coral reefs bleached and died in oceans around the world.

The CREATE Lab was then asked to bring the technology to Davos in 2015 with a warning that it would be the group's only trip to the exclusive forum.

As of 2019, it's been five years in a row.

A contingent of Carnegie Mellon University faculty and researchers, led by President Farnam Jahanian, traveled to Davos in January for the 2019 edition of the World Economic Forum.

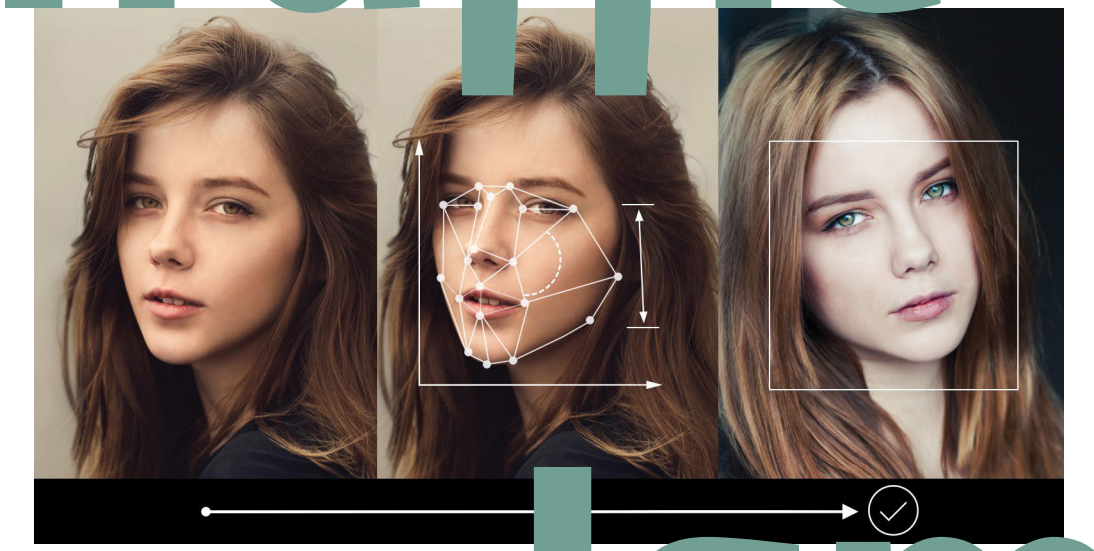
This year's theme, "Globalization 4.0: Shaping a Global Architecture in the Age of the Fourth Industrial Revolution," addressed the fragility and controversies facing leaders today, and encouraged them to build the future in a constructive, collaborative way. Carnegie Mellon contributed to the worldwide discussion in several sessions in addition to the EarthTime demonstration, including presentations on equality and bias in the workplace and global climate change.

Once again, internationally respected policymakers and business leaders stood in front of the massive 25-foot monitor in the central foyer of the Davos Congress Centre, using Carnegie Mellon software to tell the narrative of the planet's most important stories. This year, EarthTime highlighted the fate of our oceans, the warming of the planet and women in the workplace, among other topics.

"It's fascinating to see the reactions," said Sargent, a researcher at CREATE Lab. "World leaders sit down on those stools for the presentations and we hear their audible gasps — those aha! moments — throughout the week."

"Five years later, we're no longer a thing at the forum. We're a tool," Nourbakhsh said.

Traffic Jam



The Traffic Jam software package uses facial recognition to find missing people in advertisements.

CMU Spinoff Marinus Analytics Uses AI to Break Up Human-Trafficking Rings

Mark Roth

For many people, prostitution evokes images of scantily clad women walking under streetlights in a red-light district. But the reality of prostitution today comes as a flood of internet ads with lurid come-ons, photos of young women and phone contact information. For police officers who investigate sex trafficking, the sheer volume of these ads can be overwhelming.

"There are hundreds of thousands — if not millions — of advertisements on the internet for commercial sex," said Anthony White, a detective with the major crimes unit of the Fort Worth, Texas, police department. "We would spend all the hours of our day searching for individuals if we had to do it manually."

Fortunately for White and other investigators in the U.S., Canada and the United Kingdom, a Carnegie Mellon spinoff has developed software to make their jobs easier, and in the process, help rescue scores of human-trafficking victims.

The Traffic Jam software created by Marinus Analytics uses artificial intelligence to help police efficiently sort through online sex ads, grouping them by phrases, phone numbers or locations. This grouping helps detectives identify the people who control the women they have coerced — many of whom are minors.

Marinus, which is headquartered on Pittsburgh's North Side, was formed in 2014 by Emily Kennedy (DC 2012) and Cara Jones. Kennedy began working on the project when she was still an undergraduate in Carnegie Mellon's Dietrich College of Humanities and Social Sciences, and Jones left her job as a staff member of the Robotics Institute to help launch the company.

Besides using textual analysis to track down human traffickers, Traffic Jam also uses Amazon Web Services' Rekognition face-coding software to help identify victims. The software can take a missing persons photo of a young woman suspected of being exploited in the sex industry and search online to find matches in the thousands of ads posted each day.

White has benefited from both the text-analysis and image-recognition aspects of the Traffic Jam software. In one recent case, he noticed a particular piece of art on a bathroom wall where one woman had taken a selfie and he used Traffic Jam to search for other women who had taken selfies in the same location. In another investigation, White used Traffic Jam's filters to pull more than 100 ads for a certain girl and use that as evidence in court.

"There are a variety of search functions in Traffic Jam," White said. "It saves countless hours so I can focus on other aspects of the investigation."

The birth of Marinus Analytics provides a prime example of the interdisciplinary research that Carnegie Mellon is famous for. While the company's technical DNA grew out of the School of Computer Science's Auton Lab and the Robotics Institute, Kennedy herself was an ethics, history and public policy major.

Kennedy, who last year was named one of Forbes Magazine's "30 under 30" social entrepreneurs, began thinking seriously about social justice issues after a trip she made through Eastern Europe as a teen.

"We drove through a small town, and we were surrounded by children begging on the street, but they seemed desperate. I really didn't know what I was seeing," she said. "It turned out we had passed what were believed to be mob houses, and when I heard these children were being exploited by the mob to make money by begging on the street, it was shocking to me. I grew up in a very sheltered bubble."

Cara Jones Emily Kennedy (DC 2012)

> "Traffic Jam is the beginning of applied artificial intelligence to find victims of sex trafficking online. We are proud to assist the important work done by investigators across the world."
>
> — Emily Kennedy (DC 2012)

When it was time to write her senior honors thesis, Kennedy realized that not much had been written about the intersection of human trafficking and online data.

Jones, who has a degree in computer engineering and an MBA from Rensselaer Polytechnic Institute, helped mature Kennedy's ideas into a business that would offer sex-trafficking investigators a yearly subscription to its online tools.

As more and more investigators use Marinus' software, it's scored some notable achievements. This past January, the FBI in Oregon announced it had broken up an Asian brothel ring that exploited foreign nationals and operated in the U.S., Canada and Australia. The FBI took down the ring's main website and 500 other associated domains, partly with the help of Traffic Jam.

Marinus' approach treats the women involved as victims rather than perpetrators of sex trafficking. This distinction becomes important when viewed alongside the changes occurring in how many police departments prosecute sex-trafficking cases. Historically, the approach had been to focus on identifying and arresting prostitutes, with less emphasis on arresting pimps or the buyers of sex services, said Shea Rhodes, director of the Villanova Law Institute to Address Commercial Sexual Exploitation.

"It's easy for law enforcement to respond by arresting the person selling sex rather than seeking to eradicate the demand that is leading to the prostitution in the first place," she said.

But many departments are becoming more enlightened, including White's division in Fort Worth.

When Fort Worth police make a sex trafficking raid, White says, they do not arrest the women, but often take along staff members of nonprofit organizations to help the victims with clothing, IDs, health care and even finding new jobs.

"My focus is on putting the trafficker away," White said. "As long as we help the victim get out of that life, that's what matters to us."

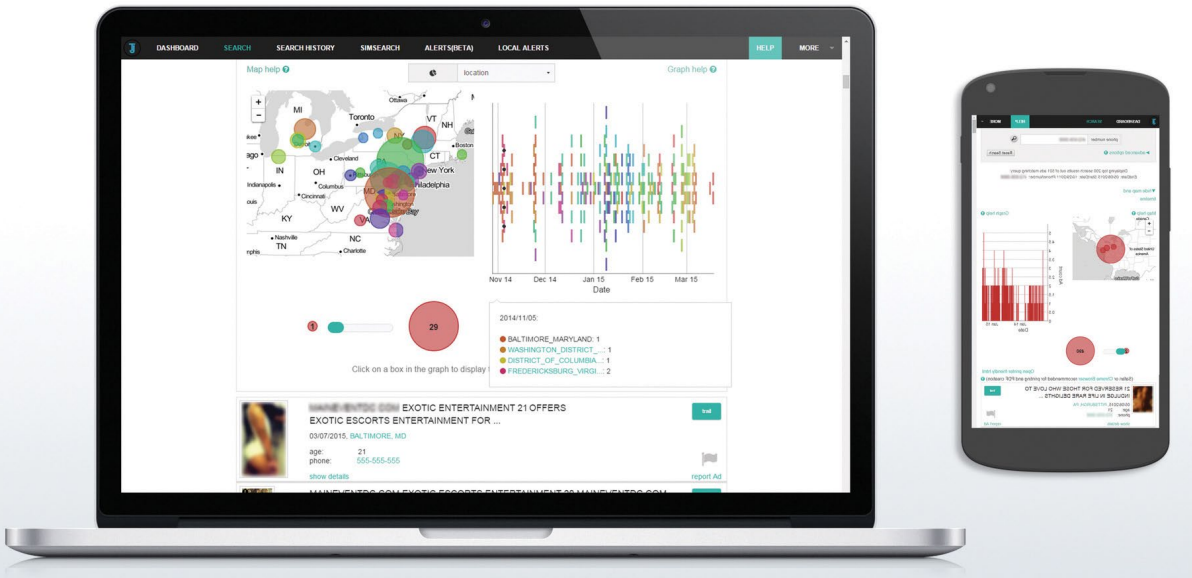
Nikki Bell, a former prostitute who runs a nonprofit in Worcester, Massachusetts that helps women get out of the sex industry, says such changes are long overdue.

"In order for [software like Traffic Jam] to be helpful, we need the police to actually care," Bell said. "I have multiple prostitution charges on my record, and never once when I was being arrested did an officer say, 'Is someone forcing you to do this and would you like some help?' Instead, I just heard, 'Put your hands behind your back.'"

Kennedy agrees. "It is crucial through training that officers should recognize the signs of human trafficking, and also be proactive about reaching out, because many women will not self-identify as victims," she said. "We are seeing more and more officers who are trained to do this, and who are having much more success in identifying the victims so they can go after the traffickers — the true perpetrators."

In a broader sense, Kennedy says she is proud of bringing AI and machine learning tools to people doing important work to protect vulnerable children and adults.

"The idea that we are bringing really advanced technologies to groups that never would have crossed paths with an AI expert is gratifying," she said. "I hope we can be the catalyst between cutting-edge AI research and people doing really important work in social services and law enforcement."



The Traffic Jam software created by Marinus Analytics uses artificial intelligence to help police efficiently sort through online sex-trafficking ads, grouping them by phrases, phone numbers or locations. This grouping helps detectives identify the people who control the women they have coerced — many of whom are minors.

One way Marinus is trying to make that happen is through a new initiative to apply its software to child protective services. Jones, who is leading that effort, says Marinus is working with Allegheny County's Department of Human Services to use AI techniques to analyze the case files of social workers dealing with children in foster care or whose families are struggling.

While many child protection agencies have computer systems that log various statistics, some of the most valuable information resides in the voluminous case files that cover interviews with families and meetings with fellow intervention specialists. The AI software could scan those files and come up with important new information, Jones says.

"For example, there might be cases where there are different family members involved with a child, and if the kid is not doing well, the software might be able to see that one of the stabilizing members of the family is no longer in the picture," she said.

For now, though, Marinus remains focused on the sex-trafficking software, which Kennedy says the company is continually refining.

"It's just a huge time saver," said White, the Fort Worth detective. "I can't imagine how difficult my job would be without the tools Marinus provides." ■

REUSE Mentors Students to Success

Cristina Rouvalis

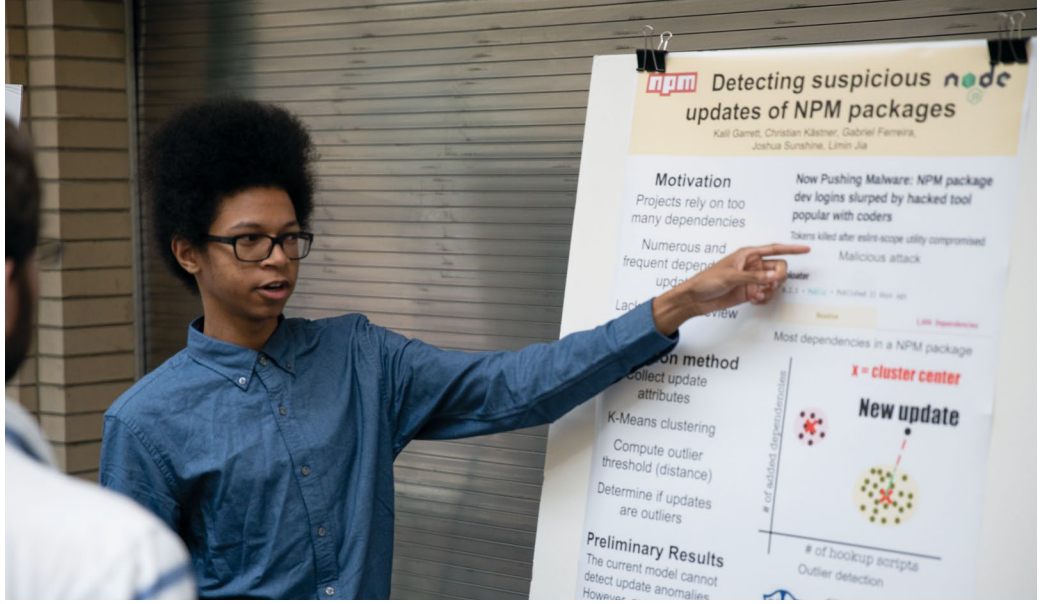
Stepping into Wean Hall for the first time, David Gray Widder saw the names on the office doors and knew he was in a different world. There was Mary Shaw, the computer scientist who received the National Medal of Technology and Innovation from President Obama. On the way to his first meeting, he passed the offices of other big names, like David Garlan and Claire Le Goues. For Widder, these computer scientists might as well have been rock stars.

A rising senior studying computer science at the University of Oregon, Widder spent the summer of 2016 doing research at Carnegie Mellon's top-ranked software engineering program through the university's Research Experiences for Undergraduates in Software Engineering (REUSE) program.

"I don't belong here," he thought to himself as he looked at the wall plaque on campus listing CMU's 12 Turing Award winners.

Nagging self-doubt persists among participants of the REUSE program. Joshua Sunshine (CS 2013), systems scientist in the Institute for Software Research (ISR) and director of the program, told a diverse group of some 20 undergraduate program participants that impostor syndrome is perfectly normal. "Everyone feels like they got in on a fluke," Sunshine said. "I still feel that way."

But Widder did belong. The 24-year-old is now a Ph.D. student at CMU, researching how people choose the right development tools in open-source communities, as well as inclusion and diversity in those communities. Like many of his fellow REUSE alumni, he says the program gave him crucial skills and much needed research experience to prepare for a top Ph.D. program in computer science.



Kalil Garrett, alumnus of the REUSE program

"These are amazing people doing amazing things."

— Joshua Sunshine (CS 2013)

"There may be people who come from a super-religious background and everyone in the family lives in the same town, or someone who goes to a regional public school close to home," said Sunshine, who also serves as the principal investigator of the program's NSF grant. "Despite the fact that an elite university might offer them generous financial aid, they don't necessarily apply. They might have to care for younger siblings, or being away from home might come at a big cost to the family."

Widder said he couldn't afford Carnegie Mellon as an undergraduate. Without REUSE, "getting into a top-tier graduate school would have been a long shot," he said.

Many of the people involved with high-level computer science graduate research attended elite high schools and competitive universities like CMU. "They have a different understanding of what classroom learning means than someone who came from a low-resource school," Sunshine said.

However, students from diverse backgrounds have unique experiences that become strong assets when tackling larger-scale societal problems such as food scarcity. "We want to build tools that everyone can use," Sunshine said. "That's why it is so important to have diversity." As it turns out, adding diversity not only provides important opportunities for the students and diversifies the field, it also makes for better science.

Widder is so enthusiastic about the program that he mentors REUSE participants, including Courtney Miller, a sophomore at the New College of Florida. Miller describes the small liberal arts college in Sarasota as having a "hippie vibe." When she arrived at CMU for REUSE last summer, the intense environment gave her culture shock.

"I thought, 'What am I doing here?'" Miller said. "David [Widder] would say, 'You are doing great. Keep on swimming.'" Regular meetings with her faculty mentor, Bogdan Vasilescu, an assistant professor in the ISR, boosted her confidence. She soon made connections and learned what it would take to get into a top graduate school.

Kalil Garrett, a second-year student at Georgia State University, spent his time in the program last summer creating a detection model for suspicious updates in the Node.js package manager, a tool for Java Script that allows for the consumption and distribution of the hundreds of thousands of modules available on the main registry.

The experience made him realize that research was a viable career path.

"As an undergraduate, graduate research seemed abstract due to my lack of experience with the process," Garrett said. "But now I am more comfortable with it and I definitely want to go to graduate school in computer science."

Joshua Sunshine (CS 2013), alumnus of the REUSE program

David Widder, alumnus of the REUSE program

Garrett's desire to go into research is common among REUSE participants. Eighty-six percent of the students who complete the REUSE program and graduate from college are doing research in graduate school or a major lab, Sunshine said.

During their 10 weeks on campus, students live in the dorms and go on group outings in the city. Widder was a social coordinator of his cohort, organizing trips to Kennywood and the museums, and planning family-style dinners. This social component strengthens the bonds of friendship and helps reduce the stress of working through the challenges that arise doing top-level research.

"You are navigating in a space where you don't know what you are doing," Widder said.

For additional support, Sunshine trains graduate students to mentor REUSE participants. Some students who take on these leadership roles incorporate mentorship into their plans for the future, as Sunshine did with his own career path.

In 2011, before CMU had a formal program like REUSE, he served as a graduate mentor to Sarah Chasins. The Swarthmore College undergrad had emailed Jonathan Aldrich, a professor in the ISR and director of CMU's software engineering doctoral program, to ask about summer research opportunities. Her work on efficient implementation of the Plaid programming language went on to win first place in the undergraduate division of the SPLASH Conference, the Association of Computing Machinery Student Research Competition.

Chasins' success was part of the impetus for CMU to start REUSE. By then, Sunshine had such a passion for mentoring students, he no longer wanted a career in industrial research.

"There is a huge pool of students around the country who didn't necessarily know they wanted to be computer scientists when they were 15 and didn't have the preparation to get into a CMU or Berkeley," Sunshine said.

The semester after his REUSE experience, Garrett co-founded a student organization called STEMulate as a way to increase diversity and inclusivity in STEM fields. One of the goals of the group is to help members enroll in quality summer programs such as REUSE.

"These are amazing people doing amazing things," Sunshine said. ■

Interested in REUSE's mission to foster diversity in research? Learn more about the program and how your support can enrich the lives of brilliant young scholars like Courtney, Kalil and David by visiting cs.cmu.edu/funds/reuse.

Tom Mitchell

Susie Cribbs (DC 2000, 2006)

Tom Mitchell has 65 first cousins. His mother, with her 14 siblings, grew up on a farm near a town whose population hasn't topped 2,000 since the 1930s. Mitchell was born there, and never visited a city — technically a "large town" — with more than 25,000 people until he went to college. And while only a few hundred miles separate Blossburg, Pa., from Pittsburgh, Mitchell's trip between the two took a few decades, with some stops along the way.

Mitchell, the E. Fredkin University Professor of Machine Learning and Computer Science and interim dean of the School of Computer Science, was born to a family of readers and educators. At age five, his family relocated from Blossburg just north into New York State, where his father was an IBM engineer. His parents lived in an excellent school district, and when he graduated, Mitchell went on to study electrical engineering at MIT.

As might be expected, Boston was a bit of a shock after spending most of his life in a small town.

"Growing up, if I was walking down the road and someone was walking up the road, I at least acknowledged them. I probably knew them! If I did, I said hi. If I didn't, I nodded or something," Mitchell said. "I got to Boston and there were so many people coming at me on the sidewalk and I was trying to acknowledge all of them. They must have thought I was a crazy man. I just did not know how to behave."

He must have worked out the kinks, though, because Mitchell met his wife, Joan (who he calls the "Associate Dean for Sanity"), while he was still at MIT. After earning his bachelor's degree, he moved to Stanford, where he completed a Ph.D. in electrical engineering and a minor in computer science. Faced with the decision between joining Bell Labs or taking a stab at university life, he opted for academia. Rutgers, specifically. He stayed there for six years — and really had no intention of leaving — until opportunity came knocking, in the form of John McDermott, then head of CMU's Computer Science Department.

"John was an artificial intelligence guy. He invited me to spend a year in Pittsburgh and CMU would pay for it, some kind of visiting position," Mitchell said. "So I came. And it was AMAZING."

That amazing experience stemmed in large part from the fact that Mitchell met Allen Newell, one of the founders of computer science at CMU, who asked him to team-teach a class that fall. And oh, Newell noted: They'd be joined by a third instructor — Geoff Hinton, a noted neural networks expert who would go on to create the technology that enables today's pervasive deep learning technology.

"The three of us taught a course, Architectures for Intelligence, that was just the most interesting and stimulating thing. At the end of the year, I didn't go back to Rutgers. I stayed," Mitchell said.

In the following decades, the computer science landscape at CMU changed dramatically — and Mitchell played a large role in its evolution. In 1997, he co-founded the Center for Automated Learning and Discovery, which in 2006 became the world's first Machine Learning Department. He ran the department until 2016, helped launch the first machine learning Ph.D. program in the country and published one of the first machine learning textbooks.

All the while, Mitchell's research was altering how we think about machines and what they can do. In typical CMU form, he collaborated with colleagues in the Psychology Department to produce a computational model to predict brain activation patterns associated with nouns — work that's evolved to other word types, word sequences and emotions. His Never Ending Language Learner searches the web and teaches itself to read. In a 2014 study, he and his colleagues, including then

Ph.D. student and current Assistant Professor Leila Wehbe, used fMRI technology to track people's brain activity as they read a chapter of "Harry Potter and the Sorcerer's Stone." The result? The first computational model of reading.

His research doesn't stop there, though. He's also interested in the future of work, and was co-chair of a study from the National Academies of Science, Engineering and Medicine on what automation means for the workforce. (Hint: Policymakers need more data to help figure that out.)

Mitchell also has big plans for future research, including using conversational AI to program smartphones. He notes that we think of having conversations with Siri or Alexa like we used to think of keyboards: say (or type) a certain command and the AI will respond appropriately.

"But that's so retro," he said. He imagines, instead, a world where we can have normal conversations with our phones, but they need to be programmed to do it. He wants to program them through speech.

"If we can do this, it would change the nature of how people and computers interact," Mitchell said. "If we can do this, I see no reason why we can't, over the next decade, turn conversation into an opportunity to teach the phone what you want it to do."

With all of his experience and honors — the university granted him its highest honor of University Professor in 2009 and he was named to the American Academy of Arts and Sciences in 2016, to name just a few — it might be tempting to leave CMU behind. But Mitchell can't imagine that.

"I love the feeling that I'm in a community where it's easy to intellectually engage with people all across campus. And I love the attitude, especially in computer science, that we're not only going to write theories about stuff, but that we're going to make it work. We're going to make it happen," Mitchell said.

"I feel like I have the ideal life. I talked to my wife, and she said 'Well, if you retired, what would you do?' And this is what I'd do. THIS would be my hobby. It's kind of like a miracle that I get to do my hobby and get paid for it." ■

SHERRI NICHOLS

THE GODMOTHER *of* SABERMETRICS

Matt Wein

Before every baseball team had an army of data analysts that tracked every pitch, swing and step. Before Brad Pitt played a baseball executive in "Moneyball." Before the book that inspired the movie was even a buzz in its author's brain, baseball's sabermetric revolution was stirring among a small group of analytics-minded fans on a Usenet group called rec.sport.baseball (r.s.b. for short).

One of the group's most prominent contributors was Sherri Nichols. And she was doing it from her computer at CMU.

Nichols can't remember a time when she wasn't a baseball fan. Growing up in Clarksville, Tennessee, she remembers throwing the ball around in the yard with her father and brother, and family trips to ballgames in the summer. She also loved math and science, and that love influenced the way she watched baseball. "I can't do anything without analyzing it," she admitted.

After earning a bachelor's degree in physics from Tennessee Tech, she was accepted to the School of Computer Science. She started her SCS graduate studies in the mid-1980s, working on transaction processing with then Associate Professor of Computer Science Alfred Spector. She left CMU to join the Information Technology Center, a collaboration between CMU and IBM, where she and her husband, David (CS 1982, 1990), helped create the Andrew File System. In 2016 the Association for Computing Machinery recognized it as the first distributed file system designed for tens of thousands of machines.

Around that same time, she discovered r.s.b. Like most of its contributors, Nichols was a student of Bill James and Pete Palmer — writers who'd been working on new, analytical approaches to baseball since the 1970s. The r.s.b. conversations that happened between the mid-1980s and the early 1990s spawned a new generation of thought about the sport, and many of the participants went on to occupy prominent positions across the industry. Some have enjoyed successful careers as sports writers. Others worked for MLB teams. Gary Huckaby, who discovered r.s.b. when he was a 22-year-old playing and managing amateur teams in California, founded Baseball Prospectus, whose annual season guides and accompanying website have helped bring sabermetrics into the mainstream.

Nichols' work didn't land her a job in an MLB front office or writing for Sports Illustrated, but it did help lay the foundation for some important modern baseball analytics.

"It's mind-blowing. It was just this little niche world that I played in," Nichols said. "It was escapist, it was fun, and it was a community where people thought about baseball the way that I did, so it was a place for me to go with all of these ideas and thoughts that I had."

She was acutely aware of her standing as one of few women taking part in the baseball analytics dialogue. But her arguments were so sharp and wry that she commanded respect from the jump. And it didn't take long for her to cultivate a reputation as someone not to be trifled with.

"It was just this little niche world that I played in. … It was fun, and it was a community where people thought about baseball the way that I did, so it was a place for me to go with all of these ideas and thoughts that I had."

— Sherri Nichols

While Nichols' participation in the Usenet group waned in the 1990s, she's left a lasting legacy in the baseball analytics world. At one point, she noticed that catchers who hit poorly were widely considered better defenders, and that catchers who hit well were viewed as defensively inferior. When she started researching it, the numbers backed her up, and the phenomenon took on her name: Nichols' Law of Catcher Defense. She also co-created a stat called "defensive average" — the number of balls fielded by a player at a position divided by the number of balls hit to that fielder's zone of responsibility while playing that position. Thirty years later, the stat is still the framework for the best publicly available defensive metrics.

"I think the reason it's held up is that it's a pretty simple concept — where did the ball go, who fielded it and how many balls does a fielder get to at his position?" Nichols said. "It depends on positioning, it depends on the pitcher. There's still a lot we don't understand about what defense actually is for an individual player."

In 1990, Nichols moved west and took a job designing software for Adobe in Silicon Valley, but her work and reputation kept her active in the sabermetrics community. She joined an effort called Retrosheet that aimed to collect and compile box scores and play-by-play data from the entirety of baseball history. In 1994, Nichols was elected to Retrosheet's inaugural board of directors and was made its first vice president and treasurer. She held the post until 2003.

While with Retrosheet, she left another enduring mark on baseball research: making all of the organization's data publicly available for free.

"It was clear that the data had value," she said. "We were already getting requests from game companies. But we wanted random people like us to be able to access the data and do interesting stuff with it."

Retrosheet remains an invaluable tool for the writers and analysts who've followed.

These days, baseball is mostly in Nichols' past. She and her family live in Redmond, Washington, near Seattle. She serves on Redmond's planning commission and the board of the state chapter of the ACLU. Her newest hobby is competitive power lifting.

She doesn't make it to ballgames often, but still pays attention to baseball. She identifies as more of a San Francisco Giants fan than a Seattle Mariners fan, owing to her time in the Bay Area and her preference for the National League. She's also a diehard Seahawks fan, and is eager to see analytics take hold in the NFL the way they did in baseball.

"I think you're starting to see it in football," she said. "Offenses are passing more, and because of the way the offenses are changing, you're seeing some shifts on defense in terms of the personnel on the field and what is valued. The linebackers are getting smaller and faster.

"The Seahawks, unfortunately, haven't caught up to it yet." ■

Scott Krulcik:
A Legacy of Paying It Forward

Kevin O'Connell

Shockwaves rippled through the Carnegie Mellon community upon hearing the news that Scott Krulcik (CS 2018) died suddenly at his desk at Google's Chelsea headquarters in New York City on Dec. 7, 2018.

The campus stood in stunned disbelief. Not Scott. That's not possible. He was only 22-years-old. He'd just graduated the previous May.

But as Tom Cortina, teaching professor and assistant dean for undergraduate education in the School of Computer, placed a call to Scott's father, Bob Krulcik, there could be no denying the truth. Scott was gone. The New York City medical examiner later determined the cause of death to be an abnormal heart rhythm.

The outpouring of grief and love for Scott has been remarkable.

"He impacted so many people here," Cortina said. "It's still something we're trying to get used to."

Cortina noted that he still can't picture Scott in his mind without seeing his beaming smile, which he donned perpetually. Others have echoed Cortina's thoughts: Scott's constant grin perfectly captured who he was.

Scott Krulcik was a special person.

Born in Saratoga Springs, New York, to Bob and Tracey Krulcik, Scott was compassionate beyond his years. He excelled in his studies and possessed an exceptional work ethic. His interests varied from academics and sports to woodworking and a deep appreciation of nature.

One of Scott's greatest talents was taking care of people. He listened to and remained present for others. And he quickly became filled with excitement from what people around him were interested in.

"Scott was a gentle soul," Tracey Krulcik said. "He would notice in your eyes if you weren't well and would drop everything to come to your aid. He took the time to say hello to people, to get to know them, to spend time watching a snowfall with an elderly neighbor, or to check in on a new student who seemed lost."

If Scott could help someone out, he rarely passed up the chance.

When Scott received his SCS acceptance letter, he was thrilled, and as he prepared to come to Pittsburgh could not stop talking about all the things he could accomplish at CMU. He found real purpose in SCS and took advantage of every opportunity.

There are simply too many stories to tell.

Jean Yang, an assistant professor of computer science in SCS and Scott's advisor, wrote the following in her blog, shortly after learning of Scott's passing:

"He talked about trying to be a good human who wants to help other humans and explained the connection with computer security. In his words, if he's producing software that helps people in some other way but leaves them vulnerable to identity theft and blackmailing, then the software isn't really helping people. Here, I thought, was a student who really got it."

Scott found great purpose in putting people at ease and making them happier. He was famous for taking advantage of the small moments in life that pass so many of us by.

Stories about Scott also flowed at the January TartanHacks 2019 event dedicated in his honor. One student mentioned that Scott once took a detour on the way to final exams to build a snowman. He asked a passing friend how she was, and she replied, "Stressed!" Scott said, serenely, "You should build a snowman!"

Mahadev Satyanarayanan (Satya), the Carnegie Group Professor of Computer Science, and his wife, Deborah Kelly, endow a Legacy Scholar each year. During his four years at CMU, Scott received that scholarship, and Satya and

"Scott was a gentle soul. He would notice in your eyes if you weren't well and would drop everything to come to your aid."

— Tracey Krulcik

Deborah got to know Scott well. They even met Scott's parents and his sister, Kristi.

In just four months as a full-time employee at Google, Scott joined a program teaching computer science to middle school students. He passionately talked to the group about ways to make the program's curriculum more appealing to kids.

Along with many others, Satya, Yang, Cortina, and Mark Stehlik, teaching professor and assistant dean for outreach in SCS, traveled to Saratoga Springs to attend Scott's funeral. Through his heartbreak, Scott's father began to talk about keeping Scott's legacy alive — about finding people who have the same spark as his son and supporting them. The entire Krulcik family wanted to pay it forward the way that Scott always had. The idea of a memorial scholarship fund in Scott's name was born.

"We started talking about what the criteria would be," Cortina said. "And we all said, 'It's Scott. It's what Scott did.' Part of it was an emphasis on strong academics and research. And part of it had to be Scott's dedication to his community."

"I think it is important to preserve Scott's legacy," said Tracey Krulcik, "because Scott's death has ended his physical presence here, his ability to directly interact and inspire others. He is no longer here to read, mingle, tinker and get full of excitement from what other people are doing. He isn't here to teach the young and old anymore. It is important to remember Scott because he set a standard for us to live by. To focus, learn, share and grow as people. It is so important to acknowledge similar individuals who share characteristics of Scott's personality and his academic acumen, so they can continue the ripple effect that these qualities have on the world."

"To quote another famous Carnegie Mellon person, Randy Pausch, 'The best time to plant an oak tree was 100 years ago. But the second best time is right now,'" Satya said. "I think that is essentially the point. There are going to be others in the future — they're not Scott — who share a similar combination of characteristics. Hopefully, we will have many of them at Carnegie Mellon. And each time such a person is honored, Scott is honored." ■

If you would like to contribute to the Scott Robert Krulcik Scholarship Fund in Computer Science, please visit cs.cmu.edu/funds/scott-krulcik-scholarship-fund.

Applying Higher Math to Networking

Bernhard Haeupler likes gossip.

In this case, gossip refers to a network communication algorithm — although it bears a strong resemblance to human gossip. The algorithm is one of the topics Haeupler studies as an assistant professor in Carnegie Mellon's Computer Science Department.

"With human gossip, you might have some piece of information, which you tell to just a random friend or two, and who also mostly keep it to themselves. Still, in no time everybody knows," he said. "In a social setting this might be undesirable, but in a computer network this is exactly what you want. You want participants to communicate as little as possible but still spread information quickly. You also want it to be really robust, so that even if many transmissions fail, the information still spreads."

Gossip algorithms, which Haeupler has been working on for about seven years, are designed to do exactly that, and they are becoming increasingly important in peer-to-peer networks, in which computers communicate with each other without coordination through a central server.

Haeupler is one of 16 early career computer science researchers in the U.S. and Canada who received prestigious Sloan Research Fellowships this year.

Another approach Haeupler is investigating to help information spread more efficiently through networks is called network coding. It's a powerful mathematical sleight of hand that involves adding together the binary digits of different transmissions in a network and then separating them again at their destinations.

If you have a packet of information called "A" and another called "B," he explained, it would seem the only way to send them through a network so they both arrive at a pair of destinations is to send each packet through separately. However, his research has shown that by adding the digital data while it's being transmitted, both packets can be transformed into a single new packet of the same size that flows to its destinations much more easily. After it arrives, the recipients can extract either packet A or B, depending on what information they are missing.

"It's as though you had an orange and an apple," he said, "and we are able to create an orange-apple hybrid, which can later become a regular apple for anyone who already has an orange but can also become a regular orange for anyone who already has an apple. It turns out by doing this, you can greatly increase the capacity of a network."

Haeupler is also interested in cutting down on errors when data is transmitted, and some of that research might have special significance in the future use of DNA to store data.

DNA, which comprises the human genetic code, can store many millions of terabytes in a single drop and stays readable for more than a million years. But DNA is also prone to information being inserted and deleted, and computer scientists need to figure out codes that will correct those errors.

Haeupler has introduced completely new techniques to address this problem, including sequences called synchronization strings. His innovations may vastly increase the reliability and capacity of future data storage systems. "The longevity and storage density of DNA is orders of magnitude greater than any other storage medium devised by humankind," he said. ■

DIRECTOR'S MESSAGE
OFFICE OF ENGAGEMENT AND OUTREACH

HITTING THE RESET BUTTON

For most people, the start of a new calendar year feels like a reset. New year, new you, new opportunities — you know the drill. But for those of us in academia, late spring brings that reset.

We say goodbye to our graduating seniors and welcome them into the alumni fold. Almost before we have time to fully reflect on their amazing accomplishments, we're preparing for a new class, and wondering what legacy they'll leave when they don caps and gowns in four years. The whole campus seems to take a deep breath and prepare for what's next. The lawns get some love, prospective students tour campus, and summer camps and enrichment programs begin and end.

Before you know it, the tent goes up for orientation and the cycle begins again.

This reset period — this big breath between one academic year and another — seems like the ideal time to talk about what's new in our alumni relations efforts.

Ashley Patton
Director of Engagement and Outreach

First, I'm happy to announce that we've added Gabriella Odusanya to our team as assistant director of Alumni Relations. In her role, Gabby will plan alumni events; organize enrichment and professional development opportunities; and overhaul the volunteer engagement program for SCS, making it easier for alums to get involved. I'm excited to have her on the SCS team, and look forward to seeing what she'll accomplish with the energy, enthusiasm and skill she brings to the position. Feel free to contact Gabby at godusany@andrew.cmu.edu, and look for her at our alumni events.

One of Gabby's first tasks was to expand our relationship with Firsthand, an online platform that we've been using to connect alums with current students to provide advice and mentorship throughout their CMU journey. We're happy with the success we've had with it, and want to offer more to our alums. Now, you can use Firsthand to connect with mentors or mentees who have affiliations with groups like ACM@CMU, the Robotics Club, the Computer Club, Women@SCS and SAMS alumni. You can also give and receive advice about changing careers, transitioning from school to work, charting a career path, applying to a graduate program, making the most of your time at CMU, developing a startup, writing a business plan, volunteering and developing partnerships. Firsthand also offers a host of webinars with career advice from industry insiders, available 24/7. Check it out at cmu.firsthand.co.

While not exactly new, our outreach efforts continue to be noteworthy. They're growing and thriving, and that's in no small part because of alumni volunteers in programs like our collaboration with Microsoft's Technology Education and Literacy in Schools (TEALS). We've also engaged SCS alumni as we work to boost the presence of underrepresented minority students in computer science. While it's too soon to know the breakdown of our first-year class, at publication time we've admitted more of these students than ever before. We're hopeful that we're creating real change, and that SCS will be a model for other universities to follow for ensuring that the people creating tomorrow's technology reflect the diversity of the world where it will be used.

As interim dean, Tom Mitchell often reminds us that it's our people who make SCS such an amazing place. I couldn't agree more. Your support for SCS helps us do what we do every day. As I take a big breath and reset for next semester, allow me to do the most important part of my job: thanking you.

Ashley Patton
Director of Engagement and Outreach
School of Computer Science
awpatton@cs.cmu.edu

Huan Chang

Huan Chang (CS 2001) has gifted the Chang Family Scholarship to assist future CS students to realize their potential in helping others

Kevin O'Connell

Tell us about your career journey after you graduated from SCS.
My first job was at Justsystems Pittsburgh Research Center working with Andrew McCallum and Jason Rennie under Scott Fahlman (also known for his inventions in emoticons and more recently popular deep neural networks). After Justsystems, I worked at a startup called WhizBang! Labs, led by my professor, Tom Mitchell, and Andrew McCallum. It was a great company associated with many talented computer scientists from SCS and outside CMU. Even though the company closed shortly after 2001, I learned a lot about commercializing information extraction and machine learning technologies. It was a great experience and I've taken what I learned there to every job I've had since.

How did your studies in SCS help guide you?
Although I had applied to study AI and was intuitively drawn to theory courses, I was also exposed to broader ideas in computer science and the computer industry. In retrospect, I realize that even before the internet boom, SCS offered "project" courses along with the cool theory-based CS classes. These project courses exercised and reinforced a major set of skills, habits and self-discipline required to work and succeed at tech startups. My favorite cooler, deeper and higher-level graduate theory courses gave me insights into the nature of science and technology. This type of exposure gave me the ability to solve harder, but quite real, real-world problems.

What about CMU culture beyond academics still resonates with you?
There are so many opportunities beyond education. And there's an excitement about CMU that keeps you going. Sometimes people need motivation to work hard, but at CMU it's baked into everything we do. With a focus on leadership and entrepreneurship, CMU students develop another level of competence. Much of the frustration that startups or tech companies experience, be it cultural, technical or in design, wouldn't occur if they hired more SCS students. Other places try to create the environment we have, but they don't come close.

You have decided to establish the Chang Family Scholarship, in part because you have a fascinating family history. Could you share a bit of that story?
My family traces its roots back at 24 generations when my ancestor migrated to the Henan province, walking barefoot and carrying his wife and child in baskets on his back and a bamboo stick in his hand. The family eventually established the Chang village.

Many years later, my grandfather, Jianhao Chang, survived the Japanese invasion and the subsequent Chinese civil war. He was the first in our family to attend college, at Wuhan University, and became a hydraulic engineer and a leader in the Yangtze River Planning Office. He was a hardworking, proactive innovator who spearheaded several innovative dam and levee projects. One of his designs was a dam built entirely of sand — the first in the world of its kind. He pioneered significant agricultural research in the growth of crops in stones next to these levees, culminating in a scientific book entitled "Stony and Sandy Lands for Agriculture." His work has withstood the test of time and continues to serve his people. He instilled in his descendants the values of honesty and hard work, to be objectively rational and to disdain fame, money and power, and to work to serve and improve the welfare of all people.

My father, Qing Chang, heeded his teachings, but focused his heart on mathematics. He is the living embodiment of Carnegie's motto "My heart is in the work." He persevered in his studies through the havoc of cultural, social and economic turmoil in the very early years of the People's Republic of China, enduring poverty and illness. After a decade of hard physical labor, he tested into graduate school, skipping college entirely. He moved the family to America. He taught us to find the greatness of America and to appreciate the opportunity gained in doing so. He continued to work hard and research mathematics, eventually earning his Ph.D. in mathematics from Penn State University — three years shy of his 50th birthday. He did so while providing for our family and beating a brain tumor.

Why was it important that you make this gift to CMU?
Because I have received so much from my forebearers, and because I had to contend with far less hardship than they did, I continue to aspire to commit my talents and diligence into achieving leadership in original engineering design and the execution of products that survive myself. It is my yearning to advance science in research, to attain advanced degrees, to continue to add to this fund, and to otherwise make lasting improvements on all people. I hope this fund will help recipients to do the same.

What thoughts or advice would you like to share with beneficiaries of this gift?
This endowment honors all those who have given of themselves to make me who I am, and to give back to future generations of students, faculty and staff at SCS and the Machine Learning Department. I hope that this bit of extra aid will help them to maximize their talents and training so they produce lasting benefits to humanity.

And, to please have fun while they're at it. ■

COMMENCEMENT

May 19, 2019

Congratulations to the class of 2019!
We present a glimpse into just a few of the many traditions and joyous celebrations for which SCS commencement is renowned.

AUTONOMOUS ROVER DEMONSTRATES THAT ROBOTS CAN FIND SUBTERRANEAN ORGANISMS

An autonomous rover named Zoë, designed and built by the Robotics Institute, drilled into the soil of Chile's Atacama Desert in 2013 and discovered unusual, highly specialized microbes. The NASA-funded mission demonstrated how robots might someday find life on Mars. The astrobiology mission was led by the Robotics Institute and the SETI Institute to test technologies for searching for life underground. The microbial analyses of the soil samples recovered by Zoë were published Feb. 28 in the journal Frontiers of Microbiology.

"This experiment culminates more than a decade of research at Carnegie Mellon developing robots that can autonomously explore the geology and microbiology of planetary surfaces," said David Wettergreen, research professor of robotics and principal investigator of the Life in the Atacama project.

"We have shown that a robotic rover can recover subsurface soil in the most Mars-like desert on Earth," said Stephen Pointing, professor of environmental studies at Yale-NUS College, Singapore, who led the microbial research. "This is important because most scientists agree that any life on Mars would have to occur below the surface to escape the harsh surface conditions where high radiation, low temperature and lack of water make life unlikely."

New Research Projects Will Close Opportunity Gap for Students

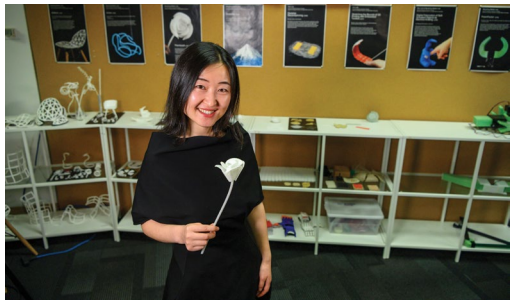
The Bill and Melinda Gates Foundation and Chan Zuckerberg Institute are sponsoring a pair of separate but complementary research projects led by the HCII that combine human support and artificial intelligence-based tutors to improve math achievement, especially in schools serving black, Latinx and under-resourced students. The Chan Zuckerberg Initiative (CZI), founded by pediatrician Priscilla Chan and her husband, Facebook CEO Mark Zuckerberg, has awarded $1.5 million for one study. The Gates Foundation, established by Microsoft founder Bill Gates and his wife, Melinda, is providing $1.9 million for the other.

"Engaging young people in successful, high-quality learning opportunities requires caring parents, mentors, teachers and peers. Cognitive tutors have been shown to also improve math achievement," said HCII Professor Ken Koedinger, who is principal investigator on both studies. "In these projects, we combine the best characteristics of humans and technology to provide these caregivers with deeper insight into what leads students toward enhanced persistence and motivation, despite the obstacles they face."

New Method Identifies Which Asthma Patients Respond to Systemic Corticosteroids

Physicians will be able to predict which of their patients with severe asthma are likely to benefit from treatment with systemic corticosteroids — and which might only suffer their side effects — with help from a dozen clinical variables researchers have identified using machine learning techniques. When processed by computer software, the newly identified set of variables will yield more precise predictions of a patient's response, said Wei Wu, a faculty member in the Computational Biology Department.

"We believe we've made progress toward making precision medicine a reality," Wu said. "Five years ago, we were only able to categorize patients clinically. Now, using incredibly complex data, we're able to predict how these subgroups will respond to a critical drug treatment."



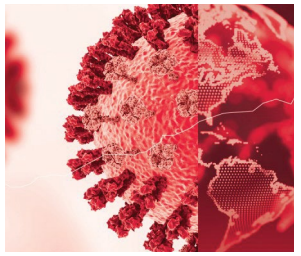
SCS Takes Show on the Road at SXSW

CMU students, faculty and alumni were among the thousands who descended on Austin, Texas, in March for South by Southwest (SXSW), and SCS was well represented among its cohort. John Zimmerman, the Tang Family Professor of Artificial Intelligence and Human-Computer Interaction, discussed efforts to improve accessibility to public transit for persons with disabilities as part of the panel on "Accessible Transportation for All." Lining Yao, an assistant professor in the HCII, demonstrated her research during the session "Morphing Into the Future: 'Shapeshifter' Materials" Finally, Christoph Mertz, a principal project scientist in the Robotics Institute and chief scientist of RoadBotics, was a finalist in the SXSW Pitch competition.

Carnegie Mellon and Lockheed Martin Sign Research Agreement

CMU and Lockheed Martin have entered into a new master research agreement that will guide future joint research projects and enable the organizations to respond quickly to new opportunities. Lockheed Martin and its Sikorsky subsidiary have sponsored research and supported student groups at Carnegie Mellon since 1986. Like a number of leading companies, Lockheed Martin has recently expressed interest in partnering with CMU on research into artificial intelligence.

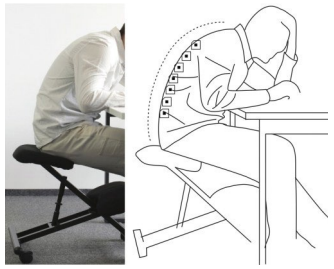
"Carnegie Mellon and Lockheed Martin have enjoyed a long, productive relationship, and this new master research agreement will help us expand and accelerate collaborations between our organizations on a range of important research topics," said Michael McQuade, CMU's vice president for research. "We are especially pleased that Lockheed Martin is joining our CMU AI ecosystem, advancing a technology that will be critical for our nation's welfare."



CDC Says Carnegie Mellon's Flu Forecasts Once Again Most Accurate

The CDC has announced that CMU's forecasts of influenza activity during the 2017–2018 flu season were the most accurate of the 30 systems in its flu forecasting initiative. The university's Delphi Research Group has proven the most accurate four years in a row, and for four of the five years that the CDC has run the forecasting initiative.

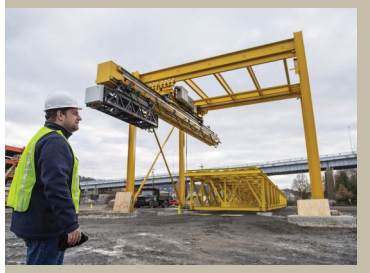
Delphi fielded two systems. The first uses machine learning to make predictions based on both past patterns and input from the CDC's domestic flu surveillance system. The second bases its predictions on the judgments of human volunteers who submit their own weekly predictions.



RFID TAG ARRAYS TRACK BODY MOVEMENTS, SHAPE CHANGES

HCII researchers have found ways to track body movements and detect shape changes using radio-frequency identification (RFID) tags embedded in clothing. This technology could be used to control avatars in video games — like in the movie "Ready Player One" — or could tell you when you should sit up straight, like your mother.

"By attaching these paper-like RFID tags to clothing, we were able to demonstrate millimeter accuracy in skeletal tracking," said HCII Ph.D. student Haojian Jin.



NREC Building What Will Be Its Largest Robot

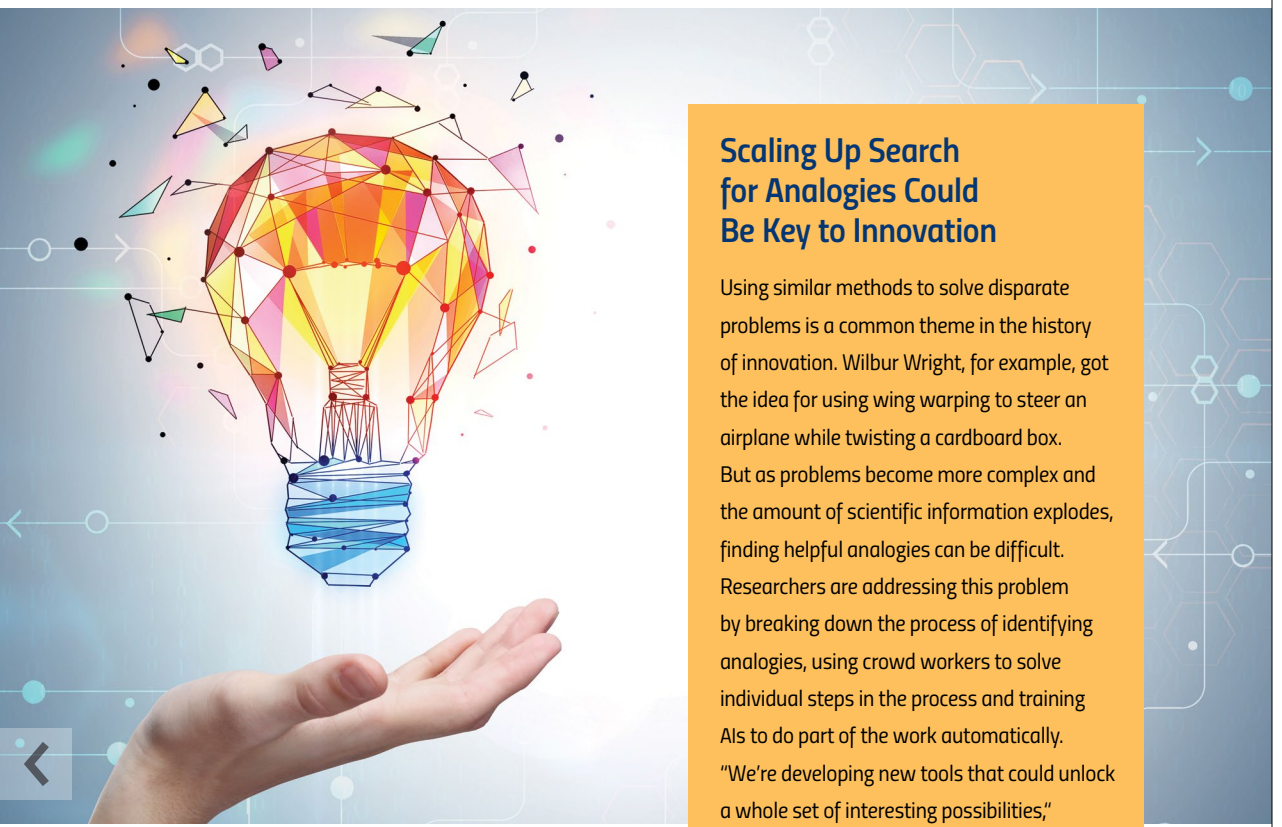
A yellow, steel structure built this past fall in front of the National Robotics Engineering Center (NREC) will be the largest robot ever constructed in the 22-year history of the organization. Its 45-foot-tall gantry was built as part of a U.S. Army Corps of Engineers prototyping project to automate its annual mat-sinking operations on the Mississippi River. The massive mats, which consist of concrete blocks wired together, shield riverbanks from erosion, helping to protect levees and ensure safe river navigation.

As big as it is, the prototype robot on NREC's front lawn will only test and further develop systems that will become part of the final, much larger robot — a floating factory called ARMOR 1 — that will eventually be deployed on barges on the Mississippi.

Carnegie Mellon Hosts Activation of U.S. Army AI Task Force

The U.S. Army activated its Artificial Intelligence Task Force at the birthplace of AI itself: CMU. The activation, which took place in February, augments the Army's long-standing commitment to modernization and future technology, while also strengthening its ties to fundamental research in academia. CMU is serving as the hub of the AI Task Force, which will eventually include other universities from across the country and engagement with the private sector.

"The launch of this national network based at CMU represents an important effort for the United States Army and our nation," said CMU President Farnam Jahanian. "CMU looks forward to working closely with our partners to ensure this robust network of AI collaborators flourishes and benefits from the long-standing strengths in AI at Carnegie Mellon and the Pittsburgh region."



Scaling Up Search for Analogies Could Be Key to Innovation

Using similar methods to solve disparate problems is a common theme in the history of innovation. Wilbur Wright, for example, got the idea for using wing warping to steer an airplane while twisting a cardboard box. But as problems become more complex and the amount of scientific information explodes, finding helpful analogies can be difficult. Researchers are addressing this problem by breaking down the process of identifying analogies, using crowd workers to solve individual steps in the process and training AIs to do part of the work automatically. "We're developing new tools that could unlock a whole set of interesting possibilities," HCII Professor Niki Kittur said.

Free, Online Coursework Helps Teach Programming Skills

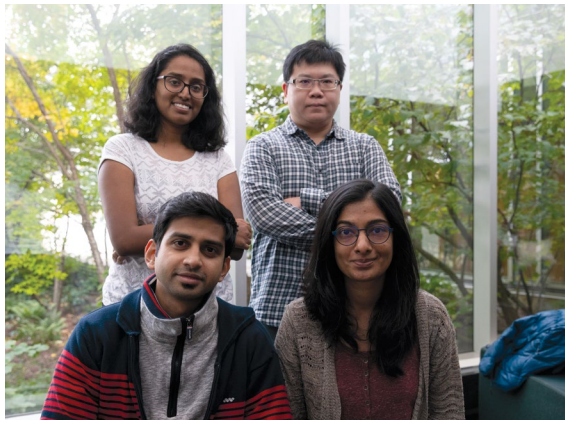
CMU has launched a free, online curriculum for high school students that helps instructors teach computer programming using engaging graphics and animations. The curriculum fills a gap between introductory computer science educational materials available for grades K-8 and the rigorous Advanced Placement courses that the most advanced students might take later in high school, said David Kosbie, an associate teaching professor and co-director of the School of Computer Science's new Computer Science Academy. Now being piloted in 40 schools, CS1 will be available for general use this fall, free of charge. It is designed for use by classroom teachers, not as a self-guided online course.

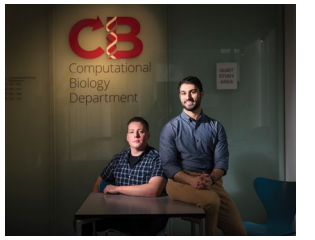
"This isn't 'drag and drop' programming," Kosbie said. "We're teaching them to use Python, a text-based programming language that is the most widely taught language at the university level."

GRAD STUDENT TEAM WINS NATIONAL HONORS FOR OVERDOSE-DETECTING WEARABLE

A team of software engineering students has developed a wearable device that could help address the unprecedented rates of opioid deaths that occur in America each year. As a capstone project for the Institute for Software Research's (ISR) professional master's program in embedded software engineering, four students built a prototype wristband that can detect overdose in the wearer and send out an alert — helping rescuers respond in time to administer naloxone, a life-saving opioid antagonist that can reverse the overdose. The team ultimately placed third in the Robert Wood Johnson Foundation's Opioid Challenge competition at the Health 2.0 Conference, held this past fall in Santa Clara, California.

"Even if you asked a group of doctors what defines the overdose, they would struggle to give you a concrete answer," team member Rashmi Kalkunte Ramesh said. "They have to physically assess the person for a variety of signals. It was on us to cull those signals and select a method of reliable, accurate assessment. We eventually honed in on a wrist-mounted pulse oximetry device as the best approach."





Neural Nets Supplant Marker Genes in Analyzing Single Cell RNA Sequencing

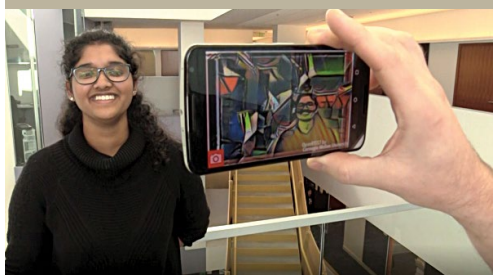
Researchers in the Computational Biology Department say neural networks and supervised machine learning techniques can efficiently characterize cells that have been studied using single cell RNA-sequencing (scRNA-seq). This finding could help researchers identify new cell subtypes and differentiate between healthy and diseased cells.

Rather than rely on marker genes, which are not available for all cell types, this new automated method analyzes all of the scRNA-seq data to select just those parameters that can differentiate one cell from another. This enables the analysis of all cell types and provides a method for comparative analysis of those cells. Ph.D. student Amir Alavi and post-doctoral researcher Matthew Ruffalo, co-lead authors on the study, explained their method in Nature Communications.

CMU and Microsoft Join Forces to Advance Edge Computing Research

CMU will collaborate with Microsoft in edge computing, an exciting field of research for intensive computing applications that require rapid response times in remote and low-connectivity environments. By bringing artificial intelligence to the "edge," devices such as connected vehicles, drones or factory equipment can quickly learn and respond to their environments, which is critical to scenarios like search and rescue, disaster recovery and safety.

To enable discovery in these areas and more, Microsoft will contribute edge computing products to CMU's Living Edge Laboratory, a testbed for exploring applications that generate large data volumes and require intense processing with near-instantaneous response times. Intel is also contributing technology to the lab.

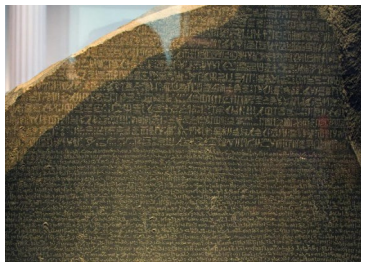


PopSci Recognizes Wheel-Track with "Best of What's New" Award

A CMU-developed wheel that can transform into a triangular track won a Popular Science "Best of What's New" award for 2018. The reconfigurable wheel-track can transform from one mode to the other in less than two seconds while the vehicle is in motion, enabling a vehicle in wheel mode to operate at high speeds on roads and switch rapidly to track mode to negotiate challenging off-road terrain. The device was recognized by Popular Science with a Best of What's New award in the security category. The magazine presents the awards annually to 100 new products and technologies in 10 categories, including aerospace, entertainment and health.

PARROT GENOME ANALYSIS REVEALS INSIGHTS INTO LONGEVITY, COGNITION

A blue-fronted Amazon parrot named Moises — or at least its genome — is telling scientists volumes about the longevity and highly developed cognitive abilities that give parrots so much in common with humans. Morgan Wirthlin, a BrainHub post-doctoral fellow in the Computational Biology Department and first author of a report in the journal Current Biology, said she and her colleagues sequenced the genome of the blue-fronted Amazon and used it to perform the first comparative study of parrot genomes. By comparing the blue-fronted Amazon with 30 other long- and short-lived birds, she and collaborators at multiple institutions identified a suite of genes previously not known to play a role in longevity that deserve further study.



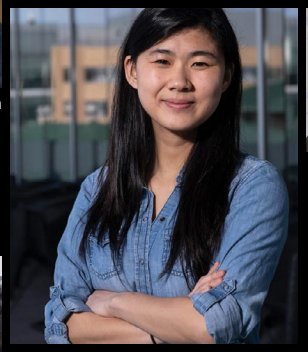
Bible Readings Help Create New Multilingual Dataset

By tapping online text and audio recordings of the New Testament in more than 700 languages, Alan Black, a professor in the Language Technologies Institute, has created a dataset that can be used to build text-to-speech computer systems and other modern speech technologies for so-called low-resource languages. These languages, such as Kaqchikel in central Guatemala, Lun Bawang of Malaysia and Indonesia, and Mamprusi in northern Ghana, often are spoken by relatively small groups of people and generally lack the kind of technological tools for recognizing or translating language that are routinely available for high-resource languages such as English, Spanish or Mandarin Chinese.

Black tapped an online service called Bible.is that provides recordings of the New Testament in more than a thousand languages to create what he calls the CMU Wilderness Multilingual Speech Dataset. This dataset, available for free download online via GitHub, includes audio, word pronunciations and other tools necessary to build text-to-speech systems.

Names in the News

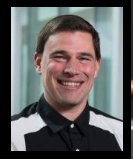

Geoffrey Hinton


Helen Zhou


Heather Jones

Thomas Moran
Lydia Moran
Amy Ogan
Jessica Hammer

Bernhard Haeupler
Hosein Mohimani




Jason Hong
Shelley Zhang
Robert Kraut
Dan Siewiorek

Chieko Asakawa


Lorrie Faith Cranor

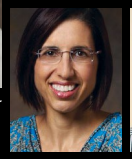
Katherine Ye

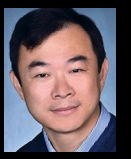
Daehyeok Kim


Illah Nourbakhsh


David Farber


William "Red" Whittaker




Mor Harchol-Balter
Venkatesan Guruswami
Eric Xing


Sara Kiesler

Geoffrey Hinton, a former CSD faculty member, will receive the 2018 A.M. Turing Award with Yoshua Bengio and Yann LeCun for their revolutionary work on deep neural networks.

Eric Xing, a professor in the Machine Learning Department and the LTI, will receive the 2019 Carnegie Science Award for Startup Entrepreneurs.

Heather Jones, a senior project scientist in the Robotics Institute, received the Young Professional Award at the 2019 Waste Management Symposia (WMS) in Phoenix for her work developing robots to detect residual uranium in nuclear weapons complex piping.

Helen Zhou, an MLD Ph.D. student, received a Paul and Daisy Soros Fellowship for New Americans.

Bernhard Haeupler, assistant professor in CSD, and Hosein Mohimani, assistant professor in the Computational Biology Department, have received 2019 Sloan Research Fellowships.

HCII faculty members Jessica Hammer and Amy Ogan received the inaugural Thomas and Lydia Moran Career Development Professorships in Learning Science.

HCII Associate Professor Jason Hong and his wife, Shelley Zhang, have endowed two professorships for junior faculty named for longtime SCS faculty members Robert Kraut and Dan Siewiorek.

Sara Kiesler, Hillman Chair Emerita of Computer Science and Human-Computer Interaction, has been elected to the National Academy of Engineering.

Chieko Asakawa, the IBM Distinguished Service Professor in the Robotics Institute and an IBM Fellow at IBM Research, is among 19 innovators who will be inducted into the National Inventors Hall of Fame this year.

Lorrie Faith Cranor, the FORE Systems Professor of Computer Science and Engineering and Public Policy, has been named the next director of CyLab, the university's security and privacy institute.

CSD Ph.D. students Daehyeok Kim and Katherine Ye have been awarded Microsoft Research Ph.D. Fellowships.

K&L Gates Professor of Ethics and Computational Technologies Illah Nourbakhsh is one of 18 newly elected Hastings Center Fellows.

Pittsburgh Magazine named Fredkin University Professor of Robotics William "Red" Whittaker one of "The 50 Greatest Pittsburghers of All Time."

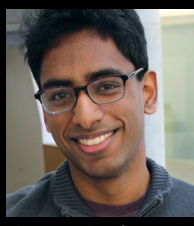
ISR's David Farber has been named a 2018 fellow of the American Association for the Advancement of Science.

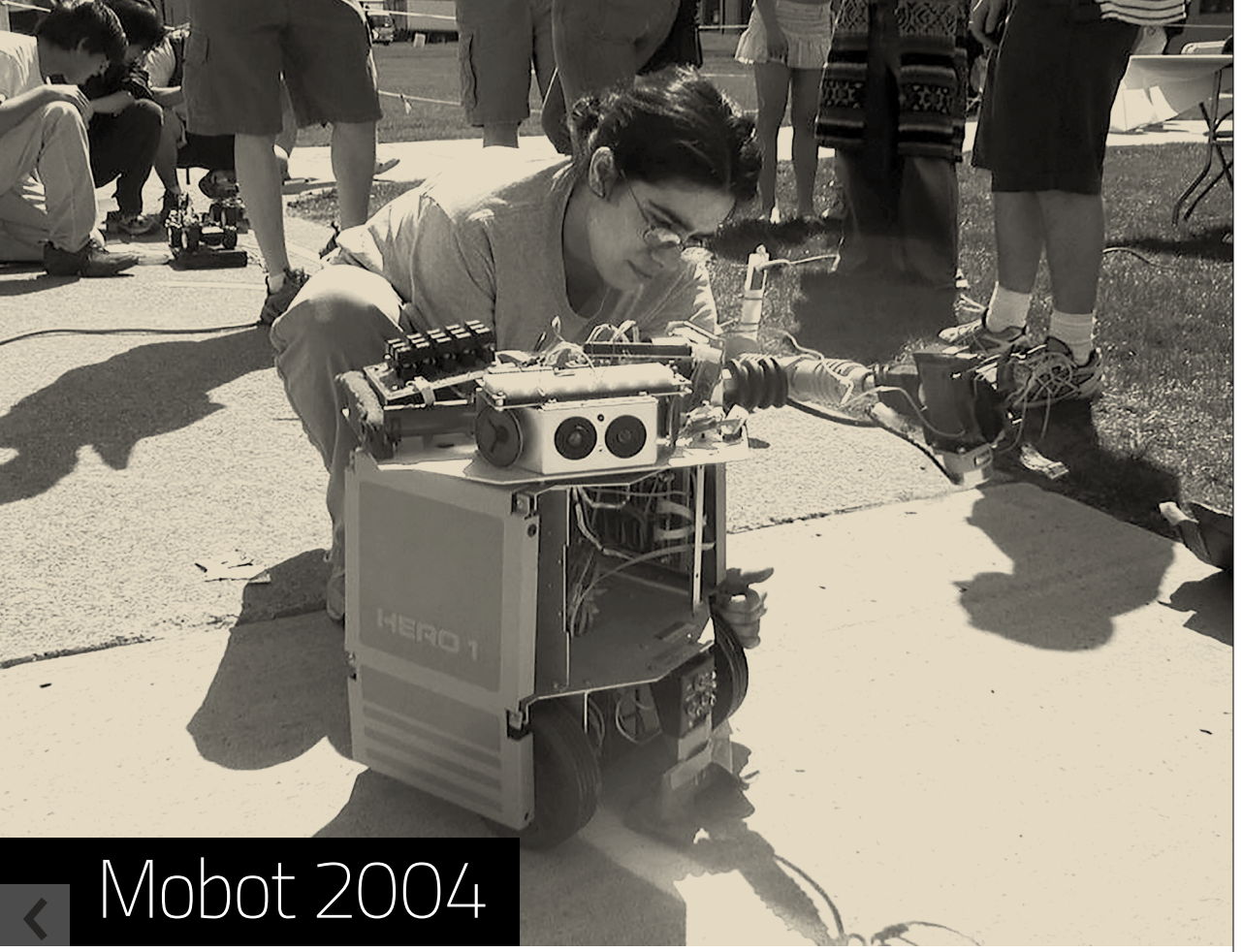
Faculty members Mor Harchol-Balter, Venkatesan Guruswami and Eric Xing have been named IEEE Fellows.

Computer Science Professor Tuomas Sandholm and Ph.D. student Noam Brown are the second-ever recipients of the prestigious Marvin Minsky Medal, which recognizes their outstanding achievements in AI.

SCS master's student Hima Tammineedi, who earned his bachelor's degree in computer science last May, has been named to the 2020 class of Schwarzman Scholars.


Tuomas Sandholm
Noam Brown


Hima Tammineedi



Mobot 2004

Mobot 2019

MOBOT TURNS 25

A Quarter Century of the Little Mobile Robots That (Mostly) Could

Cara Gillotti (DC 2006)

Nothing keeps the Mobot faithful from the course outside Wean Hall on race day.

Other Spring Carnival events might receive more hoopla. Buggy and Booth participants likely spend more time preparing for and working on them. But MObile roBOT (commonly called "Mobot") enthusiasts don't seem to mind.

"Most people are focused on school and exams," said John Palmisano (CS 2004), a mechanical engineer who won the competition multiple times. "If people sleep the night before, it usually means they gave up."

For the participants and crowds — yes, crowds — that line the sidewalk in front of Wean Hall where, for the past 25 years, the Mobot Slalom Race has taken place, it's an unmissable event. Neither rain, nor snow, nor high winds keep the Mobot faithful from watching these autonomous robots crawl along the wavy white-lined course in a quest to see which one clears its 14 gates first. Lucky for recent competitors, the walkway where the race occurs received a much-needed paving a year and a half ago.

"Prior to that it was a mess, with patches and discoloration that made using sensor-based technology challenging," said Catherine Copetas, assistant dean for Industrial Relations and director of special events.

The track forks at the lower part of the course, called decision points, require the mobots to choose the correct path if they're going to finish the race successfully. Mobots are judged on their ability to navigate sequentially through the gates, and each run is limited to four minutes. There are first-, second- and third-place cash prizes awarded to undergraduates; an open class for alumni, staff and anyone who wants to participate; and the Ben Brown Judges' Choice Prize, for creativity, good show or anything else the judges want to recognize.

The course record, set in 2009 in the Open Class division by former CMU researcher Michael Licitra and Jeff McMahill (CS 1994), made it through Gate 14 in 00:33.99. (You can watch it from both the human and the mobot perspective at cs.cmu.edu/mobot/winners)

Mobot traces its roots to a Computer Science Department meeting in 1994, when professor and founding father of computer chess Hans Berliner (CS 1974) voiced his belief that the university should pay more attention to what students were doing. He really wanted to get them more excited about what they could do, especially in the relatively new field of robotics and especially autonomous robots.

The ensuing theme after the meeting: Why not have a competition?

"It's a different challenge today. There's software that takes away the challenge of doing the low-level electronics that a lot of the early ones required." — Ben Brown

"I think he had the feeling that when Spring Carnival comes around, everyone talks about the buggy races. We should have something that's more on the science and engineering side that would let people get involved and didn't require a fraternity or other large organization," said Ben Brown, a Robotics Institute project scientist who has been involved with Mobot since the beginning. "So he came up with the idea of the Mobot Slalom Race."

The idea was so well-received that Lockheed Martin has been a sponsor since day one, and Boeing for almost as long, according to Copetas, who noted that General Motors has also long been a sponsor. "Hans designed the logo, which is still used today," she said.

A post-race debriefing known as the "15th Gate," held after the competition, allows Mobot participants to discuss what worked, what didn't and why.

"That's a great part about Carnegie Mellon," Copetas said. "It's not a big secret how you did something."

"It's a different challenge today," Brown said. "There's software that takes away the challenge of doing the low-level electronics that a lot of the early ones required. Dan Bothell won the first competition, and I think he took some pride that his didn't have an onboard computer — it was all analog electronics."

Through all the changes over the years, the students never fail to provide innovative solutions to the tricky problems that arise. And as one might expect, the look of mobots through the years has also run the gamut.

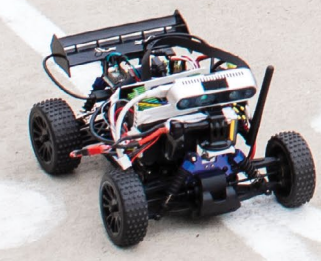
"There have been some very clunky ones, put a laptop on top of something and run it," Brown said. "There have been some interesting things that've happened when weather was bad. People would cover them up with boxes and things to keep the rain off. One was a fan-propeller-driven, swamp-boat thing, and there were a couple walking robots."

One year, students — pointing out that there wasn't a "no mammal" rule — used tuna to train a mouse to run the race. Never having seen grass before, the mouse ran over to it at the earliest opportunity.

"In a controlled environment, the mouse was very successful!" Copetas said. The event triggered the institution of an actual "no mammal" rule.

Trained mice aside, the most remarkable aspect of Mobot may be its longevity. Despite advances in technology and robotics, it's still not an easy competition. "Students still have to work at it, 25 years later," Copetas said. "It's still a good idea."

Here's to another 25 years. ■



A mobot negotiates a "decision point" during the 2019 Mobot Slalom Race.

Carnegie Mellon University
School of Computer Science

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SCSatCMU

cs.cmu.edu

calendar of events

Summer 2019
Regional Alumni Events
Check cs.cmu.edu/calendar
for events in your area

September 15
Let's Talk — Career Presentation

September 16–18
Technical Opportunities
Conference

October 25–27
Homecoming Weekend