the LINK

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

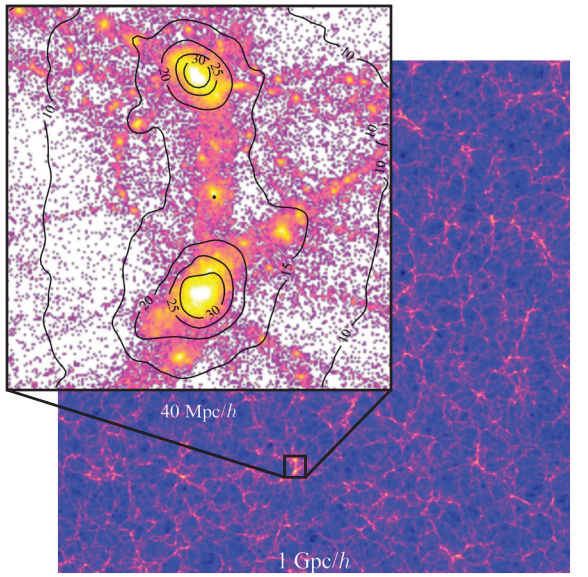
SUMMER 2018
ISSUE 12.1

MIGHTY MITES

Super Sensors for a Smart Internet of Things

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.



Computer-Driven Space Simulation

The study of astrophysics now makes use of computational methods such as machine learning to identify larger patterns in observational data that could provide insights into the evolution of the universe.

The interdisciplinary **McWilliams Center for Cosmology** joins the research efforts of astrophysicists, particle physicists, computer scientists and statisticians to unravel the mysteries of the cosmos.

One such mystery is the nature of dark matter and dark energy, which make up 95 percent of the universe.

Researchers at the center use a variety of observational, experimental, theoretical and computational approaches, including studies of the evolution of galaxies and the formation of large-scale structures using the latest tools in data mining, statistics and computer science. These experiments search for dark matter particles at the Large Hadron Collider, bolstering efforts to develop and run cosmological simulations.

The McWilliams Center for Cosmology is a collaborative effort of Carnegie Mellon's Department of Physics, the School of Computer Science, the Department of Statistics and the Software Engineering Institute, as well as other partnering institutions including the Pittsburgh Supercomputing Center and the Department of Physics and Astronomy at the University of Pittsburgh.

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Living in the Future

You probably heard the exciting news earlier this spring that Carnegie Mellon's Board of Trustees unanimously voted to name Farnam Jahanian the 10th president of the university. This news thrills me for two reasons — ones that should thrill you, too. The first reason is, of course, that Farnam has the strong charismatic leadership skills, management expertise and appreciation of our unique bottom-up culture to lead us to amazing things. And I'm not just saying that because he's my new boss. As provost and then interim president, Farnam showed remarkable enthusiasm and vision. Jim Rohr, chair of CMU's Board of Trustees, said it best in his letter to the campus community when he wrote that Farnam "embodies a bold, boundary-crossing, creative approach to the most important issues of our time — the very qualities that define and differentiate Carnegie Mellon, positioning this university to shape our world at the nexus of technology and human life."

I enthusiastically concur. Hear, hear!

My second reason for being so excited about Farnam's appointment is that he's a computer scientist. That he's one of us doesn't mean the School of Computer Science will get any kind of special attention. But it does make me feel confident about the university's commitment to the future of our field. Plus, he's just the right amount of geeky, which I mean as a compliment. (And I'm not just saying that because he's my boss.)

And honestly, it's an amazing time to be excited about computer science, at Carnegie Mellon and around the world. On campus, we've increased our undergraduate enrollment without sacrificing the quality of our students. They're still the best in the world. We're making exciting progress on our CMU AI initiative, which unites faculty members from across campus in an effort to create artificial intelligence for good.

I'm also thrilled that our new undergraduate program in artificial intelligence will begin this fall. The world desperately needs AI experts, and I strongly believe that no one does AI education better than Carnegie Mellon. SCS students can declare the new B.S. in AI after their first year on campus, and they'll take courses on how we use complex inputs to make decisions or enhance human capabilities. We're also including an ethics and social responsibility focus in the program, because we absolutely must ensure that our students look at the implications of their research and decisions. We're pretty sure this is the first program of its kind in the country, and I can't wait to get started.

This issue of The Link shows off some of the other reasons we're excited right now. Our cover story discusses the type of low-cost sensor technology that I think will quite literally change how we live. You'll also read about how our work in speech recognition has led to the development of voice forensics, and how our famous collaborative nature has allowed us to create technology that can automatically generate algorithms. We're even working on techniques to print flat objects that take on a different shape when they hit water or heat.

It's like we're living in the future.

After four years as dean, you'd think I'd be used to this stuff. But I'm not. I can't wait to see what the actual future holds. I hope you enthusiastically concur!

Andrew W. Moore
Dean, School of Computer Science

MIGHTY MITES

Super Sensing for a Smarter IoT

Nick Keppler
Story produced in conjunction with the Institute for Software Research

Researchers unite powerful, inconspicuous sensing platforms with sophisticated machine learning to expand the possibilities of Internet of Things technology

It's 2050. The first generation raised in an interconnected world, the millennials, are starting to face the ailments of old age.

Emily, a member of this generation, visits her doctor and says she's beginning to experience memory loss. She loses track of her keys, her wallet and her schedule. Emily lives alone. Her doctor gives her a set of quarter-sized computing devices called Mites, and tells her to place them around her house. They contain a combination of physical sensors that detect what's happening nearby and connect to Emily's smart speakers to tell her when her laundry's done and when she's left the oven on. They help Emily, but help her doctor even more.

With Emily's permission, her doctor downloads information from the Mites' accompanying software. At her next appointment, Emily's doctor asks if she had taken any phone calls the previous day. Emily says no. Her doctor checks the information provided by the Mites. Though the sensors don't save the contents of conversations, they registered the distinct sound of Emily's ringtone and 20 minutes of chatter. He asks Emily how she's been sleeping. Emily can't remember. The Mites reveal the sound of sheets ruffling, Emily coughing and a few trips to the bathroom during the night. The doctor is concerned.

One day, the Mites identify the sound and vibration of a body hitting the ground and detect Emily's heat signature on the bedroom floor. Acting on information from the Mites, her home emergency response system alerts medics, who arrive on the scene to ensure she gets the help she needs.

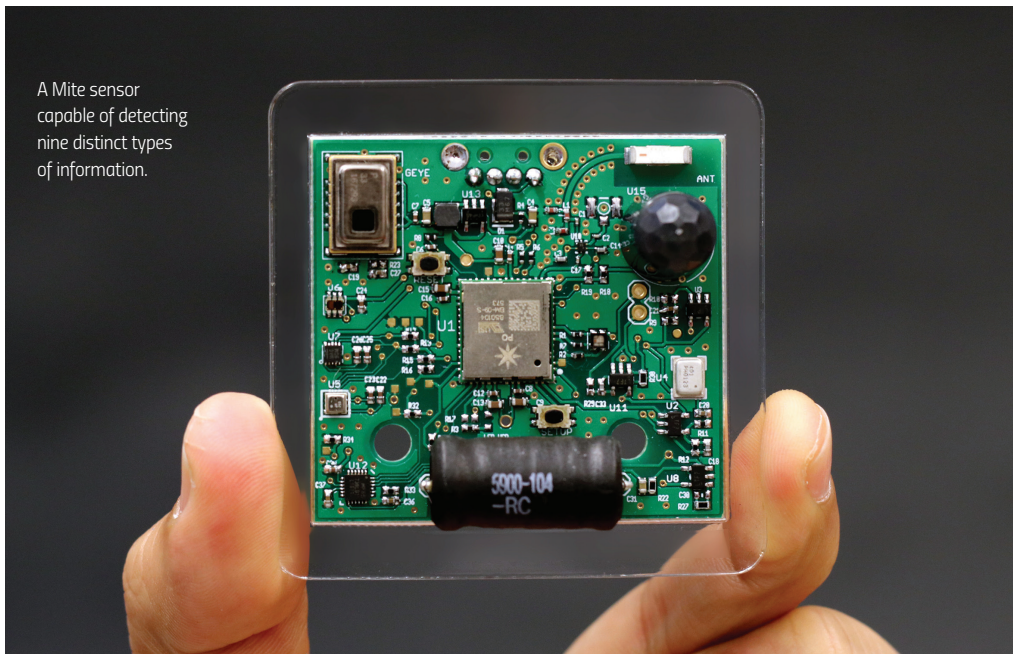
While this scenario may still seem futuristic, it's one potential application for the very real Mites, super-sensing devices developed by researchers in the Institute for Software Research's (ISR) SynergyLab and the Human-Computer Interaction Institute's (HCII) Future Interfaces Group. The flat, two-inch-square devices combine nine different sensors — including ones for vibration, audio, light, humidity, temperature, magnetism and sound — to create one all-purpose sensor that can be plugged into a small USB wall plug adapter. The sensors then connect over Wi-Fi to classifying software equipped with machine learning functionality that matches a set of environmental measures to the name of an everyday event.

That's when the magic happens.

While there is certainly novelty in providing a densely-packed sensor platform like the Mites, the possibilities become truly profound once the hardware is paired to software, which utilizes machine learning to categorize occurrences in the space. "You can essentially tell the system 'This is a faucet' and it will know what a faucet sounds like from then on," said Chris Harrison, an assistant professor in the HCII.

The idea, supported in part by a research gift from Google in 2016, approaches the smart home concept from a new angle. "One way to make a home smart is to buy $10,000 worth of appliances," said Yuvraj Agarwal, an assistant professor in the ISR. "You buy a smart washer, a smart dryer, a smart door" and so on. All-purpose sensors like Mites, however, could take all the data emitted in an environment and channel it back to the user. "It's cheaper, more flexible, and users can train it to look for things they care about," Agarwal said.

This novel approach to internet of things (IoT) technologies could expand the capabilities of digital assistants like the Amazon Echo, Google Home or Apple's Siri. Such devices are nearly omniscient when it comes to digital information like online orders, movie times and trivia, but clueless about what's literally in front of them in the physical world. But give such technology access to sensing power and a new dimension opens for them.



A Mite sensor capable of detecting nine distinct types of information.

"I'd like to ask Amazon's Alexa about my environment," Agarwal said. "Alexa, are my basement pipes freezing? Alexa, where is my son? Alexa, did I leave my stove on?"

By combining sensors that detect elements like noise, light, heat and electromagnetic interference, almost any activity or environmental factor can be measured in enough ways to generate a unique set of distinct characteristics that act like a signature. The classifying software then uses two techniques to match a signature to an event users will recognize. The user can manually identify the event. ("This is a faucet running.") Or, if the system detects an unidentified signature multiple times, it can prompt the user to identify the event it corresponds to. ("What was that sound?")

From there, it's a two-pronged system: the sensors pick up raw data from the environment and the classifying software tells the user what it means through a smart speaker, text message system or laptop. The software can also quantify the activity — for example, keeping track of how long the water has been running or the oven has been on.

Mites do all this while preserving user privacy. While the Mites absorb a constant stream of raw data, the software samples that data at defined intervals and aggregates these sampled "bins" based on statistical characteristics. The software then converts the raw data into more complex elements that describe the environment or the activity. Then it classifies the data, outputting a result. The system doesn't record voices or faces, nor does it analyze the content of conversations. Raw sensor data can't be reconstructed or transmitted.

Sensor systems like Mites could make everyday tasks more convenient — sending you a text message when your laundry is ready, keeping track of water usage or letting you know where you left your keys (by honing in on their distinct jangle and marking the time and place it last heard it). But the research team sees broader applications.

Greenhouse owners could monitor heat, humidity and plant growth, for example. Managers of stadiums and concert venues could track traffic into bathrooms and refreshment stands and stock them accordingly. Public works officials could place the sensors outdoors to monitor a city's light and noise pollution. Owners of the automated factories of the future could receive immediate notice when equipment leaks or breaks. "You could MacGyver it to do many things," Agarwal said.

The sensors also have exciting health care potential. Mayank Goel, an assistant professor in both the ISR and HCII, has long studied applications for sensing and computing in medical environments. "There is a list of conditions that develop slowly, that the patient or their doctor might not be able to detect immediately," Goel said.

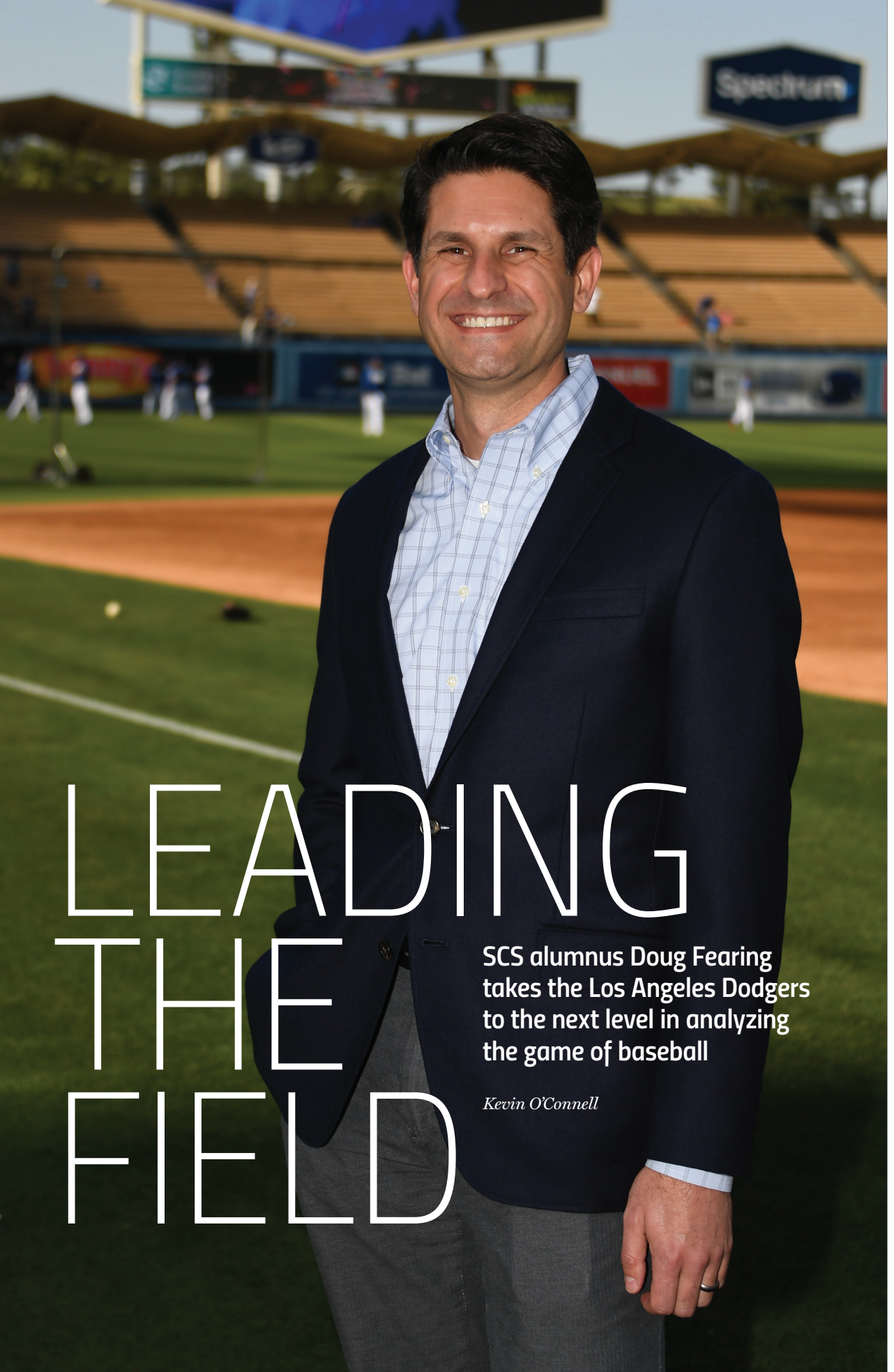
Coughing, for example, is a symptom of a variety of ailments that run the gamut from the common cold to tuberculosis. When a person thinks a cough is worthy of medical attention is subjective, and they may not be able to tell the doctor when the issue started or how quickly it intensified. In many cases, Goel says, a sensing program could provide exact data, notice other symptoms and match them to a profile of a serious disease before a human doctor could. "I think it would be particularly useful for someone with memory loss, who could not accurately tell their doctor about their symptoms," Goel said.

In the true interdisciplinary spirit of CMU, the Mites sensor and its software have been a multiyear collaborative effort between Agarwal's SynergyLab and Harrison's Future Interfaces Group, which includes Sudershan Boovaraghavan, Chen Chen, Gierad Laput and Yang Zhang. Agarwal now leads efforts to commercialize their technology.

"I can see a time when you could buy a five-pack of Mites at Home Depot to work with virtual assistants like Google Home, Amazon Alexa or Apple Homepod," Harrison said. He adds that there could be larger packets for workplaces and city blocks.

The defining feature of the sensors, though, is not their application for any one use, but the evolving way they could be adapted for multiple purposes. Most sensors are designed for and attached to the device they are trying to turn "smart." But the Mites are free agents, capable of measuring anything in their vicinity. And the classifying software is basic and can be adapted to a range of purposes.

"I think the best use of these might be for something we haven't even thought of," Harrison said. ■



LEADING THE FIELD

SCS alumnus Doug Fearing takes the Los Angeles Dodgers to the next level in analyzing the game of baseball

Kevin O'Connell

> **"I wasn't always a sports fan, but I was always a Dodgers fan."**
>
> —Doug Fearing (CS 1999)

When people ask Doug Fearing (CS 1999), director of research and development and data analyst for the Los Angeles Dodgers, what he does for a living, he often replies, "Have you seen 'Moneyball'? Well, I'm not Brad Pitt." While the day-to-day work of analyzing the data behind Major League Baseball — data that helps the top minds in the game evaluate players and improve team performance — might not be as glamorous as a Hollywood movie, Fearing still finds it a compelling way for a computer scientist to make a living.

The field of sports analytics has boomed in recent years. When the Dodgers hired Fearing three years ago, he was the only person in the department. Now he leads a team of 18 developers and analysts — all focused on creating models, tools and technologies that answer the questions baseball decision-makers ask. Questions like: Do the hitting stats of a particular minor league player bode well for them one day making the big club? Or how does changing a pitcher's grip affect the break of their slider?

Unlike "Moneyball," the information Fearing's team provides represents only part of the equation. Fearing believes what is often undervalued in analytics/data science is the ability to contextualize the information he cannot provide. Or, as he describes it, "The ability to make the limitations of the models well understood within the greater Dodger organization, so that people can then properly weight the subjective data to fill in the gaps."

One might think that because he works with the Dodgers, Fearing must have always loved baseball — or at least had long been into sports. But this wasn't the case. "I wasn't always a sports fan," Fearing says, "but I was always a Dodgers fan." Which makes sense, because before attending Carnegie Mellon, Fearing grew up in the Los Angeles area. While at SCS, he liked working on challenging mathematical problems with smart people — something that he has enjoyed throughout his career. Even with this as a guiding theme, his route to a career in baseball took a few turns.

After completing his degree at CMU, Fearing spent five years in Austin, Texas, working at Trilogy Software. As the industry moved to an outsourcing model and the forecast looked "not great," his wife, Rebecca Cassler Fearing (E 1999), received a fellowship from MIT to pursue a dual MBA and master's in engineering — and her company offered to pay her salary. It was a wonderful opportunity for the couple that afforded Fearing time to stay home with their six-month-old son. While he found being a stay-at-home dad fulfilling, he kept his active mind busy during the hours his son slept by playing online fantasy baseball games. And winning them.

"I was building these complicated draft spreadsheets for ESPN fantasy leagues," Fearing says, "and I'm not even playing with friends — just random people on the internet, who I'm sure were not very excited to have me in their league. I sort of took it to another level."

Even though fantasy baseball was something he did in his free time, the experience gave birth to Fearing's love for sports analytics. He began a master's program and eventually earned a Ph.D. at MIT's Operations Research Center, with the goal of

> "We want to have the best scouting organizations, the best player development group, the best medical and performance staff, and the best research and development team."
>
> —Doug Fearing (CS 1999)

working on sports analytics projects. As fate would have it, Daryl Morey (current general manager of the Houston Rockets) was then the senior vice president of operations for the Boston Celtics and was teaching a sports management seminar at MIT that Fearing talked his way into attending. There, the two discussed several innovative basketball-related data analytics projects, which never materialized. Morey went on to found a data-intensive system of basketball management dubbed "Morey Ball" that favored three-point shot attempts over mid-range jumpers. But the conversations the two shared helped Fearing hone in on his current path.

After completing his Ph.D., Fearing interviewed for an analytics position with the Tampa Bay Rays. Though he chose to go into academia, becoming an assistant professor at Harvard Business School, he consulted with the Rays for the next five years and helped build their research and development capabilities. Because the Rays have one of the smallest payrolls in baseball, they couldn't compete by signing expensive free agents. They had to create their competitive advantage through innovation and analytics. When Andrew Friedman made the move from the general manager of the Rays to become the president of baseball operations for the Dodgers, he lured Doug back to Los Angeles for the position he now holds — one he does not take lightly.

"We have the resources to compete in every dimension," Fearing says. "We want to have the best scouting organizations, the best player development group, the best medical and performance staff, and the best research and development team. We're one of the premier organizations in sports, and those should be the goals we set for ourselves."

Fearing finds that building a premier baseball analytics program can be a complicated endeavor. Fundamentally, statistical modeling in a physical environment seeks a set of desirable outcomes that you try to achieve. In baseball, it can be a well-hit ball or high-quality pitch production. "We look at all the inputs and try to understand, as best we can, which inputs lead to the best outcomes," Fearing says. Most the positive outcomes in baseball can be pared down to the pitcher-hitter matchup. But even with that simplification, things get complicated quickly. For the pitcher, a good question might be more about the quality of the pitch and how to best define good pitch selection. For the hitter, an important question might be what types of contact off the bat are likely to be most valuable.

Baseball stat geeks love this kind of data, which is commonly available to the public on websites like Fangraphs or Baseball Prospectus. But Fearing and his team go much deeper to apply the best methodologies they can devise, their own secret sauce, for measuring and placing value on those metrics. "You're always tinkering with the formula," he says. And for that reason, the recipe will remain a secret. Because when it works, it leads to the competitive advantage that all teams seek.

What's no secret is that the Dodgers squared off against the Houston Astros in the 2017 World Series — one of the closest and most exciting in recent memory. To arrive at that level of success, the models that Fearing and his team build take into account past performance, but they must be predictive as well. Furthermore, the most useful predictions need to tell a holistic story about a player that will allow the coaches to develop that player further. "We can't just say 'In six years, this player is going to be … this,'" Fearing says, "because it's very path-dependent. The more we describe why we arrived at a certain prediction, the more we can actually influence the development path and make sure we get the desired outcome."

Because it's impossible to model everything, Fearing recognizes that there are things the data can't pick up — nuances that their coaches and scouts have a very good feel for. Unlike "Moneyball," where Brad Pitt's character fights bitterly with scouts and player evaluators, Fearing stresses the importance of thinking of his value as not just providing answers, but also providing tools and information to help other groups within the Dodgers organization do their jobs better.

Data analytics has taken strong root in baseball, primarily because of the game's rich history in statistics and record keeping. And even if he can't model everything, Fearing sees sports analytics as a growing field, as more aspects of the games are quantified and more teams find success by analyzing data. At the same time, he's pleased that technology has yet to enter the dugout. Part of what he enjoys most about the game is watching the manager watch the pitcher, and the pitch-by-pitch assessment of his confidence and fatigue. In the end, the manager has to be the one to decide when the team should pull him out. "There's no computer that they can just go to. Once the game begins, it's a very human experience," Fearing says. ■

Diamond Kinetics

The Los Angeles Dodgers partner with Diamond Kinetics, a Pittsburgh-based startup formed in 2013, to use mobile motion technology to enhance player development. Diamond Kinetics places sensors on baseball bats that analyze and help improve the mechanics of a batter's swing. They also employ a smart baseball to capture data such as a pitch's velocity, spin rate and the time that elapses from the release to the ball crossing the plate — data that was previously unrealized. The smart baseball also assists with pitching mechanics by measuring the pitcher's arm extension, timing delivery and capturing data that measures the pitcher's reach back and release.

Two CMU alums are a big part of the Diamond Kinetics team: Mike Ressler (CS 2002), director of engineering, and Trey Marshal (E 1990, TPR 1997), director of mobile development.

The Shape of Pasta

HCII Assistant Professor Morphs Matter

Susie Cribbs

Lining Yao came of age in a small village in China's Inner Mongolia Autonomous Region. Like most of her neighbors, she didn't have a computer. She didn't even have a television. On the eve of Chinese New Year, friends gathered at the only local home with a small black and white TV to watch China Central Television's New Year's Gala. When a car drove through her village — which happened only a few times a year — people would line the street and wave to welcome it. Her family grew most of their own food and foraged for mushrooms in the forest.

Today, Yao directs the Morphing Matter Lab in CMU's Human-Computer Interaction Institute, where she studies how to design and fabricate materials that use nano- and microscale technologies to alter their own shape. Examples? Clothing that self-ventilates in response to human sweat. Furniture that arrives in a flat package and self-assembles when exposed to a stimulus like heat or water. Flat pasta that takes its characteristic shape when boiled.

It might seem like a giant leap from Inner Mongolia to Pittsburgh, but Yao made a few stops along the way. The first was Zhejiang University, where she enrolled in medical school. After two years, she realized she was better suited to a profession that allowed for more expression and exploration.

Current members of the Morphing Matter Lab come from a host of departments — the HCII, materials science, mechanical engineering, electrical engineering, architecture, design and drama.

"I learned that I prefer creativity over reciting knowledge written in medical books," she said. "As a person who deals with creative technologies and exploration, you can be highly productive even if you are young and inexperienced, as long as you are passionate."

That passion propelled her to a bachelor's degree in engineering and industrial design in China, and then to MIT Media Lab, where she earned her master's and Ph.D. in media arts and science. Last June, she joined the HCII, whose advertisement for a "radical designer" interested in research caught her attention. Because "radical" might be the best adjective to describe Yao's work.

Take, for example, the aforementioned flat pasta. Begun while she was finishing her Ph.D. at Media Lab with colleagues Wen Wang, Chin-Yi Cheng and Professor Hiroshi Ishii, the "Transformative Appetite" project generates 2D films from food materials that transform into 3D shapes when they're boiled. At the cellular level, the film material is designed to swell when it encounters water, but also contains molecular elements that help limit and control the swelling, resulting in the desired "pasta" shape. While early prototypes used gelatin as a primary base, Yao has reached out to Barilla since arriving at CMU and formed a partnership to create a substance that tastes more like real pasta.

The motivation for the flat-pasta project is two-fold. First, she hopes to prove that something as universal as an object's water absorption behavior can not only be controlled, but can also be programmed. Beyond the scientific merit of the work, though, is the impact it could have on the world. Shipping flat pasta drastically reduces costs and eliminates unnecessary packaging. In fact, Yao says her team calculated that shipping flat pasta would save nearly 60 percent on packaging costs compared to today's traditional pasta.

Yao's work doesn't stop at food, though. She's also tackling adaptive garments.

"By adaptive, I mean that all of the physical materials should understand the environment and the user, and be responsive and accommodating in a way that's more beneficial to the host and the ecosystem," Yao said.

Through CMU's Center for Machine Learning and Health, she hopes to join forces with UPMC to develop fabric that responds to a patient's fluctuations in perspiration and temperature using thermo- or water-responsive polymers. Students from her lab — which includes disciplines ranging from materials science and engineering and mechanical engineering to computer science and costume design — even developed clothing that responded to heat for CMU's Lunar Gala fashion show. This work could pave the way for sleeves that roll themselves up or jackets that puff as temperatures drop.

"One valuable element at Carnegie Mellon is that all the professors from different departments are open to collaboration, and people think together we can make the world better ..." — Lining Yao

While it might seem that Yao's work has a strong design focus, the computer science aspects of it can't be denied. All of her work — the pasta, clothing, furniture and beyond — relies on 3D printing and fabrication, which in turn relies on intense computation and graphic models that transform a 3D item into printable 2D coordinates.

Yao says that the HCII is a perfect fit for her lab because the institute allows her to explore her creativity in an interdisciplinary environment that prizes collaboration.

"One valuable element at Carnegie Mellon is that all the professors from different departments are open to collaboration, and people think together we can make the world better," she said. "That's what they told me before I took the offer, and it's what I've experienced since I arrived on campus."

If all this seems a world away from her Inner Mongolian roots, she'd be the first to tell you you're wrong. Her technology-free, nature-heavy childhood informs nearly all she does.

"Inner Mongolia is full of grass, but also forest and mountains. We used to pick mushrooms and pine cones," she said. "These all became part of the natural organisms I studied for inspiration on how nature's smart materials work."

Pine cones, she points out, have scales that close when wet, but open when they're dry — a reversible transformation from one of nature's smart materials that had a huge influence on her research agenda.

"When I share my story with friends, I always talk about my home with pride. The pine cone is only an example. In general, the Morphing Matter Lab is a bio-inspired group — plants and microorganism-inspired mechanisms are critical to what I do now. When we study a new thing, I can almost always retrieve a childhood memory from nature related to it. I think that's why I'm so motivated to study all these things." ■

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.

AUTOMATED ALGORITHM DESIGNER

Designing an intelligent system to construct complex algorithms

Linda K. Schmitmeyer

Algorithms are the brick and mortar of the digital world — the foundation on which we've come to manage many aspects of our lives. They rank our internet searches and conveniently cluster the products we buy. They map the fastest route home and analyze the mountain of medical data we generate, enhancing our doctor's ability to diagnose disease and keep us healthy.

But developing new algorithms takes time, and computer scientists struggle to keep up with the demand for these complex, efficient, reliable mathematical processes that power our digital world. Research shows that today's developers spend half their programming time debugging existing algorithms at a cost of $312 billion annually. Combine that fact with the Bureau of Labor Statistics prediction that in two years there will only be 400,000 graduates to fill 1.4 million computer science jobs, and you have trouble.

A team of Carnegie Mellon researchers hopes to address this problem by developing an Automated Algorithm Designer (AAD), an intelligent system that constructs complex algorithms from scratch.

"Creating effective algorithms is a problem computer scientists have studied for a long time," said AAD team member Carl Kingsford, an associate professor of computational biology in the School of Computer Science. "Doing so requires human ingenuity, and our hope is to automate that ingenuity."

The team's ambitious goal — automating an aspect of human intelligence — is part of Carnegie Mellon's longstanding tradition as a leader in artificial intelligence research. "CMU is the place that really studies the nature of intelligence and how to harness it for the good of the world," SCS Dean Andrew Moore said. Artificial intelligence plays a vital role in finding solutions to global challenges like the emerging food crisis, optimizing energy use and mining massive amounts of health data.

"Having a system that will break the bottleneck generated by our increasing need for well-constructed algorithms will serve as a powerful tool for finding solutions to these problems," Kingsford said.

In the case of the AAD, AI will help meet the needs of people who want a computer to do something, but currently require a computer scientist to make it happen. A biologist, for example, may need an algorithm that detects the mixing of influenza strains, or a biotech company may require one to sequence genomes. "An AAD would allow people without algorithmic training to construct algorithms at the level of an accomplished undergraduate computer science major," Kingsford said.

"Having a system that will break the bottleneck generated by our increasing need for good algorithms will serve as a powerful tool for finding solutions to these problems."

It sounds simple, but the research challenges are substantial.

To be effective, an AAD must be able to discover algorithms that are provably correct, highly efficient, concise, easy to understand and capable of running on parallel processors. Designing an AAD requires uniting a number of different systems, according to Kingsford.

"The big goal is still many years away, but there has been progress on various aspects of the project that is promising," he said. "The team members' current research serves as building blocks for the system we envision."

For example, SCS Assistant Professor Jan Hoffmann's automated static complexity analysis should allow for pruning inefficient algorithms. Professor Guy Blelloch has created enhanced cost models for parallel programs that improve estimations of an algorithm's resource requirements. Maria-Florina Balcan, associate professor of machine learning and computer science, has developed new approaches that provide provable statistical guarantees on the output of machine learning algorithms, including the design of automatically learned clustering algorithms. And Kingsford has created a domain-specific system for the automated design of network-growth algorithms. Professor Anupam Gupta, whose research focuses on algorithm design and analysis, is also involved in the project.

The initial phase of the project involves developing an intelligent system that supports human designers. Dubbed a "weak AAD," it would augment computer scientist's creativity and search capacities, but depend on people to verify the algorithms it produces. The second phase requires developing a so-called "strong AAD." It includes expanding the scope of the problems being tackled, increasing the library of algorithmic building blocks, strengthening the performance guarantees of the algorithms produced and developing theory to guide the system.

In speaking to a group of scientists gathered at CMU in 2000, SCS founder and Nobel Prize winner Herb Simon (H 1990) said, "Our task is not to predict the future; our task is to design it."

With this Moonshot, the Automated Algorithm Designer research team is doing just that. ■

RESEARCH PROFILE: RITA SINGH

The Forensics of Speech

Nick Keppler

In 2014, Language Technologies Institute researcher Rita Singh got a call from the U.S. Coast Guard's investigative unit. For a few years, stations in the Atlantic Ocean had received distress calls over high-frequency radio that turned out to be hoaxes. They were short, just "Mayday" or "Help me," and came from the same person. Each call triggered a costly search-and-rescue mission. The caller got some kind of thrill from calling during storms, so the missions placed Coast Guard personnel at serious risk. The Coast Guard asked Singh, an expert in voice recognition, what she could tell them about the caller from the brief voice recordings.

Like many audio experts, Singh had been working on speech recognition at the time — making a computer understand spoken language. Using a computer to identify a caller posed a new challenge. "My previous work was all about transcribing speech, all about the content of the speech," Singh said. "For the work with the Coast Guard, content wasn't important. I had to look at other signals."

Decades of research provided some of those signals. The height, weight, ethnicity, health and region of origin of a speaker could be determined based solely on their

"THE VOICE IS BEING SEEN AS A KEY MARKER OF DISEASE. SIGNS OF ILLNESS CAN APPEAR IN THE VOICE BEFORE THEY APPEAR ANYWHERE ELSE."

voice. Experts could also pinpoint many characteristics of the equipment used and about the location where a piece of audio was made based on reverberation and background noise. It was all a matter of putting together a system of algorithms that could apply all these predictors and indicators, and then running the recording through it — which is what Singh did.

Singh determined that the hoax caller was most likely a white man around 40, about 5'7" and 165 pounds who grew up in the U.S. (likely the Northeast). Singh guessed he was in a warehouse, with many machines running, and radioed on homemade equipment from a room with a glass wall. He was probably sitting in a metal chair on a concrete floor.

While Singh can't discuss specific cases, she says the Coast Guard apprehended the suspect and most of her predictions were correct. She immediately changed the focus of her research. "I dropped it that day," Singh said. "I was not going to do any more work on voice recognition. Let the Googles and the Alexas do that." Now, she focuses on audio forensics and regularly receives requests from law enforcement agencies asking her to analyze clips.

Singh again says she can't discuss specifics of those clips and projects, but news reports have detailed the value of audio forensics for law enforcement and intelligence-gathering agencies. The National Security Agency has developed "audio fingerprints" for high-priority fugitives and uses them to determine the authenticity of messages supposedly from them. (The agency had sets of voice signifiers for Osama bin Laden and Saddam Hussein.) An audio forensics expert told Wired Magazine that the voicemails and surveillance recordings of people interacting with drug dealers can be rich with data. Child pornography clips can be scanned for clues about the identities of the victims, and the time and place of the crimes.

Mahmoud Al Ismail, a research associate working with Rita Singh, attempts to re-create faces from voice.

Audio forensics could also potentially disclose truths about secretive regimes. A South Korean audio expert recently claimed North Korean dictator Kim Jong-un's voice indicates he suffers from a kidney disease. Singh says she has analyzed recordings of Adolph Hitler and speculates he was afflicted by Parkinson's disease in his later years. (Some historians had long held this theory, partially based on Hitler's habit of gripping his hands behind his back while at the speaker's podium.)

Singh notes that the system isn't magic. "They know I am never 100-percent sure," she said. But based on the unique muscles and tissues that come together to create the human voice and the wealth of audio clues provided by various environments, she can tell a lot from a small clip.

Currently, all of Singh's consultation is pro bono. "I'm not doing this for money," she said. "I'm happy to do it." She refines her process by working on real mysteries. "There is no data like real data," she said.

Singh presented her technique at the World Economic Forum in Davos, Switzerland, this past January. There, she rubbed elbows with celebrities and saw world leaders, such as President Donald Trump. If they bumped into each other, they would have something to talk about. During the 2016 election, Factcheck.org enlisted Singh to determine if a Trump "spokesperson" recorded on phone calls with celebrity magazines and newspapers decades ago was actually Trump himself. Singh said it was.

At Davos, a few actors and finance types suggested Singh's field would provide a good basis for a screenplay. (Not much of a movie viewer, Singh says she may have offended a certain actress by failing to recognize her.) But for the next phase of her work, Singh has her sights set on goals loftier than a spy thriller plot device.

"The voice is being seen as a key marker of disease," Singh said. "Signs of illness can appear in the voice before they appear anywhere else." Audio analysis can detect deterioration in the muscles that create the voice and glitches in the mental processes that choose and pronounce words. What if a part of the world without health care infrastructure had a voice booth where a patient could create a recording and a computer oceans away could use it to detect conditions ranging from multiple sclerosis to lung cancer? Singh says that's a possibility.

She also plans to continue to develop her forensic capabilities. Given the information about height, weight and facial structure relayed by a voice recording, Singh foresees a world where it would be possible to create a visual representation, even a holographic one, of a suspect from his or her voice.

"The framework has been there for years," Singh said. "We've hypothesized about the voice. We've come up with all these microfeatures and micropatterns, and we know about the very fine level of detail in the human voice. We know how to measure it. We know how to use algorithms. We've just been waiting to design the right algorithms and for the technology to catch up. I think that's what's happening now." ■

Carnegie Mellon Launches Undergraduate Degree in Artificial Intelligence

The School of Computer Science will offer a new undergraduate degree in artificial intelligence beginning in the fall of 2018, providing students with in-depth knowledge of how to transform large amounts of data into actionable decisions.

SCS created the new AI degree — the first offered by a U.S. university — in response to extraordinary technical breakthroughs in AI and the growing demand by students and employers for training that prepares people for careers in AI.

"Specialists in artificial intelligence have never been more important, in shorter supply or in greater demand by employers," said Andrew Moore, dean of SCS. "Carnegie Mellon has an unmatched depth of expertise in AI, making us uniquely qualified to address this need for graduates who understand how the power of AI can be leveraged to help people."

U.S. News and World Report this spring ranked SCS as the No. 1 graduate school for artificial intelligence.

The bachelor's degree in AI will focus on how complex inputs, such as vision, language and huge databases, are used to make decisions or enhance human capabilities, noted Reid Simmons, research professor of robotics and computer science and director of the new AI degree program. AI majors will receive the same solid grounding in computer science and math courses as other computer science students. In addition, they will have additional course work in AI-related subjects: statistics and probability, computational modeling, machine learning and symbolic computation.

Simmons said the program also would include a strong emphasis on ethics and social responsibility. This will include independent study opportunities in using AI for social good, such as improving transportation, health care or education.

Students accepted by SCS as first-year students will be able to enter the AI degree program in their second year. Enrollment will be limited to 30-35 students accepted each year.

Just as artificial intelligence unites such disciplines as machine learning, natural language processing, computer vision, robotics and human-computer interaction, instruction in the AI program will draw on the faculty of SCS's Machine Learning Department, Language Technologies Institute, Robotics Institute, Human-Computer Interaction Institute, Institute for Software Research and Computer Science Department.

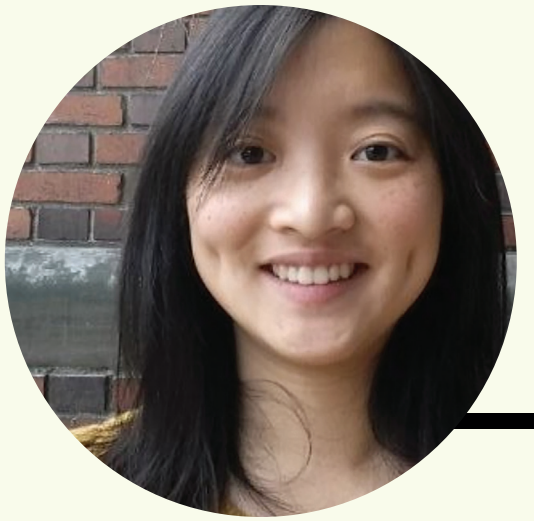
The degree will leverage CMU's traditional strength in cross-disciplinary instruction, particularly in exploring the ethical and societal implications of AI, by involving faculty members from the Dietrich College of Humanities and Social Sciences, the Heinz College of Information Systems and Public Policy, and the College of Engineering.

Giving Back to SCS

"I give because SCS has a wonderful faculty, staff and student body who taught me how to learn, enabled my success and remained understanding when I failed.

There aren't enough words to describe the patience and effort invested in the quietly critical moments of teaching, grading and innumerable events and situations that I remember. Giving reminds me what I really want to provide one day: the time and effort to uphold the vision and values I learned from 'yinz':

1. Success, to show you were right to believe in me,
2. I used what you taught me, and
3. You positively impacted me with everything you maintained."



Connie Wen (CS 2014)

DIRECTOR'S MESSAGE
OFFICE OF ENGAGEMENT
AND ANNUAL GIVING

NO LAUREL-RESTING HERE

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

As the top computer science school in the country, it would be easy to rest on our laurels and assume that the status quo is good enough. We have lots of applicants. Our programs are growing and thriving. SCS is in pretty good shape.

But we're Carnegie Mellon. And we're not laurel-resters.

Computer science as a field faces many challenges, not the least of which are gender and racial disparity. While we've made progress on gender representation in our undergraduate program, we acknowledge that we have miles to go to increase the number of historically underrepresented minorities in both SCS and the computer science field in general. We also know that there's a huge CS knowledge gap between kids in underfunded school districts versus those in affluent school districts.

We're trying to change all that. We've established an outreach initiative in the SCS Dean's Office, and we're working hard to introduce students to computer science well before they get to college. We've joined forces with Microsoft's TEALS initiative to pair CS experts with local teachers to team-teach computer science in the Pittsburgh Public Schools. We coordinate alumni talks at high schools.

One thing all these initiatives have in common is that we need your help for them to succeed.

Usually in this column, we talk about donating funds — and those will always remain vital to the work we do in SCS. (You need only flip through this issue of The Link to see what a difference they make for us!) But as alums and friends of the School of Computer Science, you're in an amazing position to help us by giving us your time.

Volunteers play a huge role in our success, and we have opportunities at all commitment levels. Here's a short list of ways you could help. They aren't all focused on outreach, but they're all important.

- If you're short on time, you can talk to kids about CS in various places across the country, though we're focusing mostly on New York City, Pittsburgh, San Francisco and Seattle.

- We've partnered with TEALS, as we mentioned earlier, and they're always looking for volunteers to teach. Don't worry — you won't be alone! You'll be in a classroom with an experienced teacher who will rely on your technical CS expertise as you team-teach the students. And you don't have to be in Pittsburgh or Seattle to participate, either. TEALS is active in many cities, and you can even volunteer to teach via Skype if there's no classroom near you that needs help.

- Remember how hard SCS was? Or how hard it seemed when you were a student? Help ease a current student's frustration or lead them down an exciting career path by becoming a mentor. We've teamed up with Firsthand, an online portal that connects current SCS and ECE students with alumni mentors who can help them through the ups and downs of their programs.

- We rely on an alumni volunteer team each May to choose the Alumni Award for Undergraduate Excellence. Open only to SCS students who complete a senior thesis, the award recognizes factors like contribution to the state of the art; technical excellence; potential societal impact; accessibility; quality of the written, oral and poster presentations; and the excitement generated among the alumni judges. (That's you!) You could be part of the group that picks next year's winner!

This is just the tip of the volunteer iceberg. If you have any interest at all in donating your time and talents to SCS, we'd love to talk to you. Send us email. Give us a call. Stop by the office if you're on campus.

But certainly don't rest on your laurels. ■

Ashley Patton
Director of Engagement
and Annual Giving
School of Computer Science
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Mathilde Pignol and Curt Bererton

Mathilde Pignol (CS 2002, 2004) and Curt Bererton (CS 2000, 2004) are the founders of Roboto Games. They spent their years at SCS and since graduating building games and gaming companies.

Tell us about your career journey?
How did you get started making games?

Shortly before graduating from CMU, we made a big matrix of possible places to live with criteria such as proximity to family and good career options. That led us to the San Francisco Bay Area, where Mathilde joined eBay as a UI designer then frog design as a design consultant, and Curt worked for several years applying machine learning to video games at AiLive.

We both wanted to start a company but thought one of us would keep working a stable job. However, when Curt had the idea for Playcrafter, a website where anybody could make games easily by dragging and dropping game pieces, Mathilde thought it would be a fun design challenge. In April 2007, we borrowed money from our families and quit our jobs to start ZipZapPlay. Playcrafter seemed promising at first, with more than 100,000 games created using the platform. Unfortunately, while we had executed the technical and design sides well, we had a key problem with our business model. We decided to pivot the company.

Our expertise in Adobe's Flash technology transferred well to Facebook, so we decided to try out social games. We quickly built three games in four, five and six weeks respectively before we made a game that took off. It was called Baking Life. In the game, you run a bakery and hire your Facebook friends to work for you as bakers, cashiers or janitors. At its peak, in the summer of 2010, 1.5 million people were playing it every day. Using revenue from the game, we grew the team from five to 17 people.

In the fall of 2010 Mathilde fell ill, which made us reevaluate our priorities. We loved what we were doing, but we also wanted more stability and less stress. We started looking for potential acquirers. In 2011, we sold to PopCap Games — the makers of Plants vs. Zombies and Bejeweled. ZipZapPlay became PopCap San Francisco (because PopCap is based in Seattle). Life was rosy, and our team was happy.

Things changed in a big way when just two months later PopCap Games sold to Electronic Arts. We went from a company of fewer than 20 people to being part of a company of 8,000. Furthermore, we were working on a game that very closely resembled a game that EA had in development and we had to scramble to figure out a new project. Ultimately, we prototyped and pitched ideas until our new project was approved and we were given a significant budget and a tight deadline. We grew our team to 45 people and shipped Plants vs. Zombies: Adventures for Facebook in May 2013 just as EA announced they were no longer developing games for the Facebook platform. We did a lot of soul-searching and ultimately decided that we needed to take a serious break. After taking a good chunk of time off, we started a new company: Roboto Games. It's just the two of us again (for now) and we are having a great time.

How did your time at CMU influence you?

Our time at CMU had a great deal of influence on our lives. We met at CMU and got married shortly after we graduated. We met many of our closest friends while at CMU. We were inspired by the projects we worked on and classes we took. For Mathilde, it was Building Virtual Worlds taught by Randy Pausch. For Curt it was building robots, AI research and applying research concepts to video games and the cutting-edge research in AI, graphics and games. Our initial ZipZapPlay team was mostly CMU graduates. When we grew the team, we added many more people from CMU, especially from the Entertainment Technology Center. Simply put, we wouldn't be where we are if we hadn't gone to CMU.

What do you enjoy most about what you do?

Nobody needs to play video games. Making games is challenging because you need to make something people want to interact with. Game creators also tend to be fun and interesting people, which makes it a pleasure to come to work every day. We especially like making games that bring people together, like Playcrafter and Baking Life. The game we are currently working on will be playable with hundreds of people at the same time. We look forward to playing it with our kids.

Starting a company is its own challenge. Building a talented team to work on a great idea and surviving until you can make it work is incredibly difficult, but also immensely rewarding. CMU students and graduates are especially lucky because we have great people around us who can work together to build amazing things.

Tell us about the pool table you donated?

When Curt was working on his Ph.D., there was a pool table directly outside of his office and he would play to take a break and think about research problems. It's good to take breaks and make connections with people, especially when you're working on something as challenging and open-ended as a doctoral thesis.

We wanted the plaque to read "Have fun. Make the world a better place." Our advice to most people just graduating is to try lots of things and find things that are both fun and impactful. If you're not having fun, you should change what you're doing. For us, it's always been starting companies and making games that connect people and bring them together, but everyone needs to find their own path and keep trying until they get there. ■

Playcrafter

Hima Tammineedi

Aisha Rashid

From building transportation devices with the CMU Hyperloop team to organizing hackathons with CMU MellonHeads, SCS rising senior Hima Tammineedi is busy. But the computer science major — who's also pursuing a machine learning minor — knows that he's been incredibly fortunate to expand his computer science interests and participate in meaningful activities with his friends. And because of that, he's made it a personal goal to give back to his community and to encourage his peers to do the same.

As a member of CMU's Student Giving Committee, Tammineedi helps the Office of Annual Giving encourage more students to give back and donate to the university through events, fundraisers and other activities.

"If you compare CMU's endowment to other institutions of our caliber, you'll notice that we have a much smaller endowment — around one-seventh or less of the size of our peer institutions," he said. "CMU has already done so much even with this smaller endowment, but we could do more if we had even more support from alumni, and especially from students."

One of the committee's most successful events was a casino night fundraiser for seniors graduating this spring. In addition to competing in games and raffles, students attending the event could also donate to CMU. The committee also encourages students to donate within their departments, through funds like the Mark Stehlik SCS Alumni Undergraduate Impact Scholarship. This year, in honor of Stehlik graduating his 3,000th CMU student, a group of SCS alumni has pledged to donate $4,000 to the fund if more than a third of the Class of 2018 donates to CMU.

"It doesn't matter how much you give, it only matters whether you give," Tammineedi said. "The strength of an institution is not measured by the amount it earns, but from what it produces. That production comes from people who make up the institutions. If students gave even $5, if that's within their means, over time that adds up and contributes to the power of people donating."

Tammineedi's passion for giving back to his community, especially to SCS, stems from the opportunities he says he was fortunate to receive. "As I become an upperclassman, I feel like my time here is ending soon. It's made me more aware of what I want my time here to be like and what I've gotten out of CMU," he said.

While Tammineedi acknowledges that it is not within everyone's means to donate, he still encourages students to give back to their communities in any way they can.

"College is a transcendent moment in our lives, because here is where we have the greatest upward learning trends and the greatest number of peers open to friendship and collaboration," he said. "It's a slingshot that brings us into the rest of our lives. CMU specifically has given me a lot of opportunities, and I'm sure it's been great for others as well. I want to preserve that, and make it better for others." ■

Commencement marks not only the crowning achievement of hard work and the celebration of a job well done, but also announces new beginnings and opportunities.

Congratulations to all our newly minted SCS graduates and their families!

Commencement
May 20, 2018

2018 Honorary Degree Recipient, Shafi Goldwasser (MCS 1979), the most recent CMU recipient of the Association for Computing Machinery's Turing Award, the highest honor in computer science

Jahanian Named CMU President

Nationally recognized computer scientist and entrepreneur Farnam Jahanian has been appointed the 10th president of Carnegie Mellon University.

Jahanian's distinguished career in academia, industry and the public sphere — and the many realms where those sectors intersect to support research and education — led him to Carnegie Mellon in 2014 as vice president for research. He then served two years as provost and took over last July as CMU's interim president.

With the strong support of the university's trustees, as well as academic and administrative leaders, Jahanian has led a period of accelerating momentum in education and research at the nexus of technology and human life. The board of trustees voted unanimously on Jahanian's appointment in March.

"A rigorous, international search has made it clear that Dr. Jahanian possesses a rare set of qualities and experiences that make him exactly the right leader for this university at this extraordinary moment in its history," wrote James E. Rohr, chair of the CMU Board of Trustees, in a message to the university community. "Dr. Jahanian embodies a bold, boundary-crossing, creative approach to the most important issues of our time — the very qualities that define and differentiate Carnegie Mellon, positioning this university to shape our world at the nexus of technology and human life."

At a campus celebration earlier this spring, Jahanian said he was humbled by the opportunity.

"Today, I am deeply honored to accept this appointment as the next president of this great institution, in the fantastically vibrant city of Pittsburgh," Jahanian said. "It is a great privilege and a tremendous responsibility. Together, we will continue to do work that matters — work that benefits people all around the world."

Former SCS Dean James Morris Delivers a Final Lecture

Professor Emeritus James Morris, former dean of the School of Computer Science and a legend in his field, gave a rich and lively lecture looking back on his career in May. He primarily discussed the other giants he encountered along the way — telling stories of Alan Perlis, Herb Simon, Robert Taylor, Allen Newell and Raj Reddy, among others.

After attending Carnegie Mellon, Morris earned his master's and doctor's degrees in management and computer science, respectively, from MIT. In 1969, he became an assistant professor of computer science at the University of California at Berkeley. There, he contributed to important underlying principles of programming languages. He also was a co-discoverer of the Knuth-Morris-Pratt string search algorithm, a fast method for locating a phrase inside a large body of text.

Morris returned to Carnegie Mellon in 1982 as a visiting fellow from the Xerox Corporation and founding director of the Information Technology Center (ITC), a joint venture with IBM. As ITC head from 1983 to 1988, he helped to conceive and engineer Andrew, one of the world's first university-wide computing and communications networks.

From 1992 to 2004, Morris served as department head and then dean in the School of Computer Science. He held the Herbert A. Simon Professorship of Human-Computer Interaction from 1997 to 2000. He was the dean of CMU's Silicon Valley campus from 2004 to 2009, which he also helped create. He also is a founder or helped to establish CMU's Human-Computer Interaction Institute and Information Networking Institute, the consulting firm MAYA Design, the Robot Hall of Fame and iCarnegie.

"I was trying to emulate these great leaders of the past, to do what I can to help the institution, but it's really to honor them that I was doing these jobs," Morris said. "They were impossible acts to follow. I couldn't possibly match that, but I was attempting to help."

Carnegie Mellon Qatar Signs Agreement To Establish Center for K-12 CS Education

Carnegie Mellon University in Qatar (CMU-Q) and the Jassim & Hamad bin Jassim Charitable Foundation signed a Memorandum of Understanding to create the Hamad bin Jassim Center for K–12 Computer Science Education.

The center aims to educate students in the fundamentals of computer science, helping to develop basic computational thinking skills. The center will also expose and raise awareness among students about the importance of computer science to the future of a knowledge-based society.

The curriculum for the center will be based on Alice Middle East, the educational, interactive software developed at Carnegie Mellon and adapted to a Middle East context at CMU-Q through funding from the Qatar National Research Fund. The curriculum will also focus on Mindcraft, a CMU-Q workshop for high school students that introduces them to computer science disciplines such as robotics, cryptography and computational thinking.

"I will be leading the Alice effort and Khaled Harras, program director and associate teaching professor, will be leading the Mindcraft side," said Saquib Razak, associate teaching professor in computer science at CMU-Q. "We have both been working closely with Fadhel Annan, assistant dean for government and corporate affairs, who has been instrumental in getting the funding to get the center up and running."

Their efforts will include training educators who will teach the Alice Middle East curriculum in their schools.

Seshan Named Computer Science Department Head

SCS Dean Andrew Moore appointed Srinivasan Seshan head of the Computer Science Department (CSD), effective July 1. He succeeds Frank Pfenning, who will return to full-time teaching and research.

"We are all excited about Seshan's new role as head of CSD," Moore said. "He is an outstanding researcher and teacher, and I'm confident that his expanded role in leadership will help the department reach even greater heights."

Seshan joined the CSD faculty in 2000, and served as the department's associate head for graduate education from 2011 to 2015. His research focuses on improving the design, performance and security of computer networks, including wireless and mobile networks.

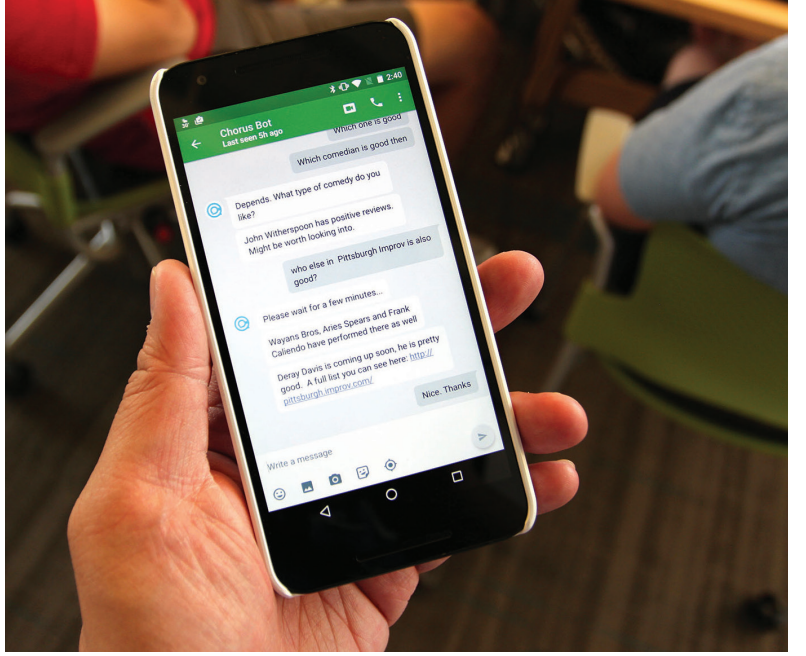
Seshan earned his bachelor's, master's and doctoral degrees in computer science at the University of California, Berkeley. He worked as a research staff member at IBM's T.J. Watson Research Center for six years before joining Carnegie Mellon.

Cake-Cutting Protocol Inspires Gerrymandering Solution

Getting two opposing political parties to equitably draw congressional district boundaries can seem hopeless, but CMU researchers say the process can be improved by applying an approach kids use to share a piece of cake. Just as having one child cut the cake and giving the second child first choice of the pieces avoids conflict, having two political parties sequentially divide up a state in an "I-Cut-You-Freeze" protocol would minimize gerrymandering.

The protocol, developed by Associate Professor of Computer Science Ariel Procaccia and Associate Professor of Mathematical Sciences Wesley Pegden, calls for one political party to divide a state map into the allotted number of districts, each with equal numbers of voters. Then the second party chooses one district to "freeze" and remaps the remaining districts as it likes. The process repeats until all districts are frozen.

"The big selling point for our approach is you don't have to rely on independent agents," Procaccia said. "We can leverage the competition between Republicans and Democrats to produce an equitable result. Each party can pursue a strategy that guarantees it something that it wants."



Crowd Workers, AI Make Conversational Agents Smarter

Siri, Alexa and Cortana are great at giving you the weather, but flummoxed when asked for unusual information or follow-up questions. By adding humans to the loop, CMU researchers have created a conversational agent that's tough to stump.

The new agent, Evorus, recruits crowd workers on demand from Amazon Mechanical Turk to answer questions from users and then vote on the best answer. It also keeps track of questions asked and answered and, over time, begins to suggest these answers for subsequent questions. The researchers have also developed a process by which the AI can help approve a message with less crowd-worker involvement.

Evorus isn't the first chatbot to use human brainpower to answer a broad range of questions. What sets it apart, says HCII Associate Professor Jeff Bigham, is that humans are simultaneously training the system's artificial intelligence — making it gradually less dependent on people.

"Companies have put a lot of effort into teaching people how to talk to conversational agents, given the devices' limited command of speech and topics," Bigham said. "Now, we're letting people speak more freely and it's the agent that must learn to accommodate them."

Seventeen Magazine Names CMU a "2018 Cool School"

We've known it for a long time, but now the word is out: Seventeen magazine has named CMU one of its 2018 "Cool Schools," citing the large number of women enrolled in science, technology, engineering and mathematics programs. The editors noted CMU's "strong community of female coders," and mentioned that the School of Computer Science class of 2020 is almost 50 percent female. Women@SCS, the pioneering group that has helped SCS adopt a more inclusive and diverse culture, is recognized for its Big Sister/Little Sister program for undergraduates and its efforts to help women find fellowships and grants.

"Job and internship prospects aren't too shabby either," they noted. "Recent CS students have ended up at Google, Amazon, Facebook, Pinterest, Squarespace and Disney."

The 2018 Cool Schools List is in the March/April issue of Seventeen.

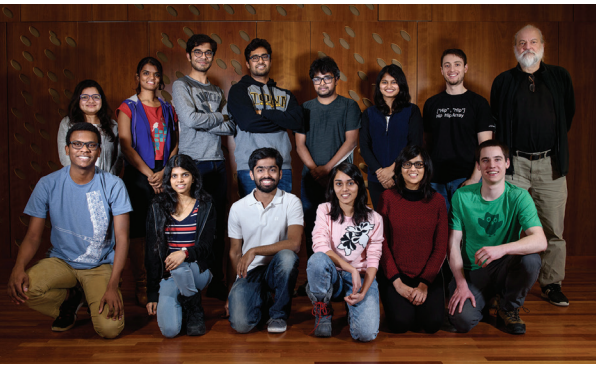
Tartan Team Competes for 2018 Amazon Alexa Prize

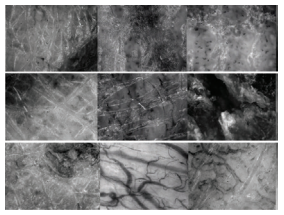
Amazon has selected a CMU team as one of eight worldwide to compete for its Alexa Prize. Each team, including CMU's 11-member group, will receive $250,000 to develop technology for conversational artificial intelligence.

The winning team earns a $500,000 top prize, while their university receives a $1 million research grant if its socialbot can sustain a conversation for 20 minutes with a rating of 4.0 or higher. (Last year's winning team had an average rating of 3.17.)

Alex Rudnicky, emeritus faculty and project scientist in the Language Technologies Institute (LTI), will mentor the Tartan team, and George Larionov, an LTI Ph.D. student, will manage it. Rudnicky led one of two CMU teams that competed in the inaugural Alexa Prize contest last year. He noted that Amazon chose eight teams rather than the 12 that competed last time, and has dramatically increased funding for each. That's a recognition, he said, of the technical challenges involved in conversational AI.

"This isn't a 'spare time' kind of thing, an extracurricular activity," Rudnicky said. "You have to have some real research going on."





Carnegie Mellon Will Help Develop Camera To See Through Skin

Carnegie Mellon is part of a five-year, $10 million National Science Foundation program to develop a camera that peers beneath the skin to help diagnose and monitor a wide variety of health conditions.

The interdisciplinary effort, led by Rice University, will combine advanced optics and sophisticated computation to make sense of light that penetrates the skin but scatters off internal tissues and anatomical structures. This will allow noninvasive bio-optical imaging at a cellular scale — something not possible with ultrasound, X-rays and other medical-imaging technologies.

"Bioimaging today enables us to see just a few millimeters beneath the skin," said Srinivasa Narasimhan, a computer vision researcher and professor in CMU's Robotics Institute who is associate director of the new project. "We'd like to go five to 10 times deeper. With every additional millimeter we go, this technology becomes more useful. We hope that eventually it might reduce or eliminate the need for biopsies."

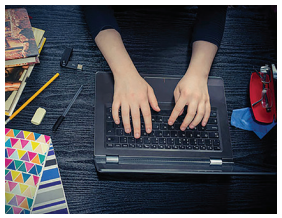
The program includes four co-investigators at CMU and another seven from Rice, Harvard, MIT and Cornell.

New AI Helps Make Sense of Privacy Policies

A team led by CMU researchers has launched an interactive website aimed at helping users make sense of their privacy on the web.

The team used AI algorithms to crawl 7,000 of the most popular websites' privacy policies and identify ones that contain language about data collection and use, third-party sharing, data retention and user choice — among other privacy issues. On the project website, people can navigate machine annotated privacy policies and jump directly to statements that interest them, including those often buried deep in the text of privacy policies.

"We've combined crowdsourcing, machine learning and natural language processing techniques to extract annotations from privacy policies that help answer key questions that users often care about," said Norman Sadeh, a professor in the Institute for Software Research (ISR).



Ph.D. Women Take Women@SCS to the Next Level

Graduate women are bringing new and exciting opportunities to CMU's Women@SCS program. Directed by Carol Frieze, Women@SCS creates and supports academic, social and professional opportunities for women in computer science.

While Women@SCS aims to promote a healthy and supportive community for all CS students, the organization has renewed its efforts to tackle the obstacles graduate women face through mentoring, outreach and career-focused programs. The graduate programs in Women@SCS not only facilitate relationships between Ph.D. students, but also help establish and foster an uplifting community for women to learn, grow and achieve as leaders.

"By creating opportunities for women in computer science to speak frankly to one another in a safe environment, Women@SCS helps us feel a sense of community. This gives us the strength to take on more challenges in the wider CS community," said Nicole Rafidi, a Ph.D. student in the machine learning and neural computation programs.

Radiation-Measuring Robots Go Where Humans Can't

A pair of autonomous robots developed in the Robotics Institute will soon drive through miles of pipes at the Department of Energy's former uranium enrichment plant in Piketon, Ohio, to identify uranium deposits on pipe walls.

The robot, RadPiper, has demonstrated that it can measure radiation levels more accurately inside the pipe than is possible with external techniques. In addition to savings in labor costs, its use significantly reduces hazards to workers who must otherwise perform external measurements by hand, garbed in protective gear and using lifts or scaffolding to reach elevated pipes.

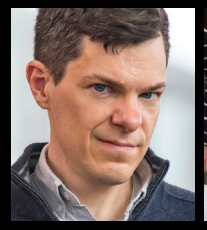
"This will transform the way measurements of uranium deposits are made from now on," said William "Red" Whittaker, robotics professor and director of the Field Robotics Center.

Names in the News

Roberta Klatzky

Chris Harrison

Bryan Parno



Andrew Pavlo

Andreas Pfenning

Lorrie Faith Cranor

Claire Le Goues

Mor Harchol-Balter
and Venkatesan Guruswami

Roberta Klatzky, the Charles J. Queenan Professor of Psychology and a professor in the HCII, has been named an IEEE fellow for her contributions to human visual, auditory and haptic perception in robotics and virtual environments.

Computer Science Department faculty members Mor Harchol-Balter and Venkatesan Guruswami were named ACM fellows.

Institute for Software Research Ph.D. student Jessica Colnago and Robotics Institute Ph.D. student Xiaolong Wang are among 23 Ph.D. students named Facebook Fellows and Emerging Scholar award winners for 2018.

Jessica Colnago

Xiaolong Wang

Faculty members Chris Harrison, Bryan Parno, Andrew Pavlo and Andreas Pfenning have received 2018 Sloan Research Fellowships, which honor early career scholars whose achievements put them among the best scientific minds working today.

Lorrie Faith Cranor, a professor in the ISR and the Department of Engineering and Public Policy, received the SIGCHI Social Impact Award. Her former Ph.D. student Blase Ur won the group's Outstanding Dissertation Award.

ISR Assistant Professor Claire Le Goues has received an NSF Faculty Early Career Development (CAREER) Award — the agency's most prestigious award for junior faculty.

Daniel P. Siewiorek

Tuomas Sandholm

Howie Choset

Abhinav Gupta

Louis-Philippe Morency

Daniel P. Siewiorek, the Buhl University Professor of Electrical and Computer Engineering and Computer Science in the Human-Computer Interaction Institute, has received the 2018 IEEE Computer Society Taylor L. Booth Education Award.

Proofpoint Inc. has acquired CMU spinoff Wombat Security Technologies Inc. for $225 million. Wombat was founded 10 years ago by SCS professors Norman Sadeh (ISR), Lorrie Faith Cranor (ISR) and Jason Hong (HCII).

Tuomas Sandholm is the first recipient of CMU's Angel Jordan Professorship in Computer Science.

The Robotics Institute's Howie Choset is among four faculty members appointed to new Kavčić-Moura Professorships. Choset will be the Kavčić-Moura Professor of Computer Science.

Abhinav Gupta, an associate professor in the Robotics Institute, was selected for the Office of Naval Research 2018 Young Investigators Program.

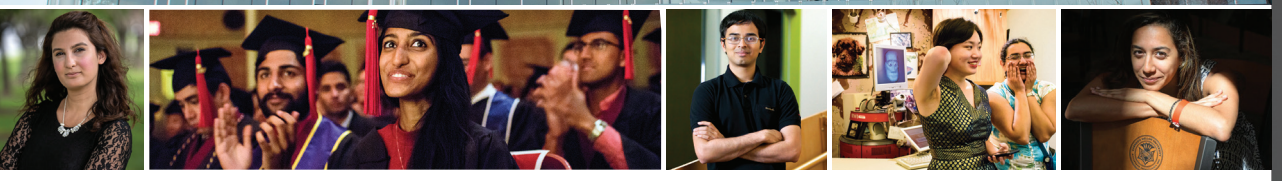
The LTI's Louis-Philippe Morency received the three-year Finmeccanica Career Development Professorship in Computer Science.

Alumni Advisory Board Chair Andrew Widdowson (CS 2005) received the university's 2018 Alumni Service Award.

SCS alum and CMU trustee Ed Frank (CS 1985) has been named to the National Academy of Engineering.

Andrew Widdowson

Ed Frank



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

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

TEALS Volunteers Contribute to CS Classroom Success

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

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

*Data from 2017 end-of-year student survey

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School of Computer Science

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The Shape of Pasta

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calendar of events

July 28
2018 World Artificial Intelligence Competition For Youth (WAICY 2018)

August 26
Semester and Mini-1 Classes Begin

September 21–22
HackCMU

September 23
Let's Talk

September 24–26
Technical Opportunities Conference

October 12–14
Family Weekend 2018

October 27
Homecoming