Conduit

DEPARTMENT OF COMPUTER SCIENCE
Brown University // Vol. 26

REACHING OUTWARD

BROWN LAUNCHES A NEW DATA SCIENCE INITIATIVE

MOSAIC+ AND BROWN CS DEBUT A NEW PROGRAM TO HELP URM STUDENTS TRANSITION TO STUDYING CS

CO-EVOLUTION: COMPUTER SCIENCE AND JOHN SAVAGE'S FIRST 50 YEARS AT BROWN

Notes From The Chair

BY UGUR CETINTEMEL

I'm delighted to share exciting news about the growth of our department. Since last spring, we made a record five new faculty hires: Theo Benson, Kathi Fisler, George Konidaris, Daniel Ritchie, and James Tompkin. These new faculty members significantly strengthen us in a number of strategic areas, including software-defined networking, software and computing education research, robotics, computer vision, graphics, and computational design. Moreover, we're currently looking to hire multiple faculty members in machine learning. These hires are being done as part of a substantial strategic growth plan for CS that has been approved by the Brown administration in collaboration with our Data Science Initiative. You'll soon hear more about our growth plan and the associated campaign to fund these new positions.

I'm also happy to highlight our junior faculty and their achievements. This past year, George Konidaris received an Air Force Office of Scientific Research (AFOSR) Young Investigator Research award only a few months after his arrival at Brown. Stefanie Tellex won the NASA Early Career Faculty Award. Tim Kraska received a Sloan award, bringing us to a total of seven and giving us an impressive record of winning four years in a row!

We're truly grateful to all of our alums and friends who have supported our UTA endowment campaign. Last fall, we announced our first named UTAs funded by the endowment! As of February, 2017, we're at ~$7.5M with a $1M challenge gift (from a generous anonymous alum) that will kick in when we get to $9M and get us to our $10M goal. Later in this issue, please read the letter from Norm Meyrowitz '81, who has been doing a remarkable job leading the campaign, about our current status and how you can help us get to the finish line.

Speaking of our alums, Sridhar Ramaswamy PhD '95, the SVP of Advertising and Commerce at Google, received the first Horace Mann Medal given by Brown to a computer scientist. This is an award given annually to a Brown Graduate School alum who has made significant contributions to their field. We're proud of Sridhar's remarkable accomplishments in technology and business and their daily impact on so many people worldwide.

Our multidisciplinary initiatives are making good progress. Our new Executive Master in Cybersecurity program welcomed its inaugural cohort last October. 28 students from diverse backgrounds and sectors (including technology, retail, law, healthcare, and government) passed through the Van Wickle Gates; for a period of 16 months, they'll develop a deep understanding of the technological, legal, political, and societal issues surrounding cybersecurity. Our Data Science Initiative (DSI) was also officially launched last fall and its new Master's program is set to start next fall. DSI will move to its own space in the SciLi later this semester. With the addition of George Konidaris, our robotics group and the Humanity-Centered Robotics Initiative has gained even more momentum, continuing to tackle important technical problems while keeping a close eye on the societal impact of robotics technologies and AI.

I'm also happy to report that RI has started taking steps towards establishing itself as an innovation hub. Several companies, including GE and Johnson and Johnson, have already decided to have a significant presence in Providence to leverage local talent and nearby universities. Brown and CS are significant attractions for these companies, with whom we're hoping to create multi-faceted relationships in research, recruiting and education.

I'd like to end with an invitation to join us in celebrating our colleague, John Savage's 50 years at Brown. It's a true delight to recognize another co-founder of our department, two years after we cheered Andy van Dam's 50-year anniversary. John has made distinctive and long-lasting contributions to CS and Brown with his research, service, and teaching. The spectrum of topics he's studied range from computational complexity to nanotechnology to cybersecurity, and they collectively mirror the organic growth of computer science as a discipline. We'll have this event on May 26, 2017, combined with our annual reunion, and hope all of you can be with us!

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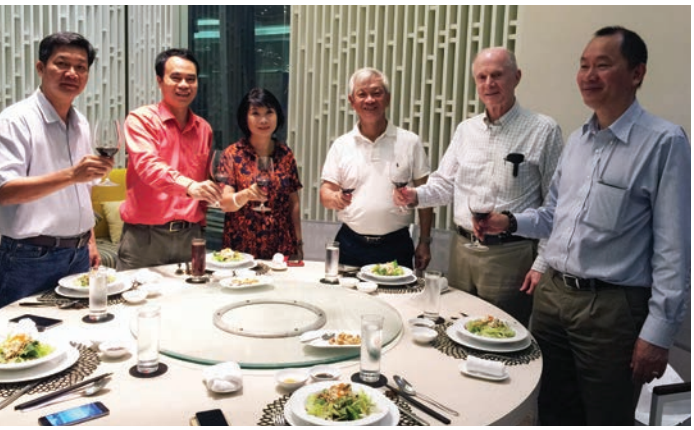
John Savage Meets

With Vietnam's President And Thought Leaders To Improve The Country's Cybersecurity



Now in his fiftieth year at Brown University, Professor John Savage continues not only to consult on cybersecurity at the international level but serve as ambassador and architect for countries that are joining the global effort to improve the safety of cyberspace.

Most recently, John has returned from a week-long trip to Vietnam, where he met with political leaders, technology and cybersecurity experts, academics, and students to address what Vietnam sees as a top priority: building the necessary cyber resilience to protect their scientific and technological development. His agenda was extremely varied, ranging from discussions of an innovation center being built in the coastal city of Nha Trang to a keynote address at the Conference on Solutions for Practice on Global Citizenship Education in Cyber Civil Defense in Vietnam, held at Dalat University.

John traveled to Vietnam as a representative of the Boston Global Forum, a non-governmental organization founded in December, 2012, by Governor Michael Dukakis; Mr. Tuan Nguyen, Member of the Harvard Business School Global Advisory Board; Professor Thomas Patterson of the Harvard Kennedy School; and Professor John Quelch of the Harvard Business School. Boston Global Forum is dedicated to solving global issues of peace and security, especially in cybersecurity.

Some highlights of John's trips are detailed in the photos on left, and you can go to http://bit.ly/2gJovzs to see a video clip (in Vietnamese) of his meeting with President of Vietnam Tran Dai Quang.

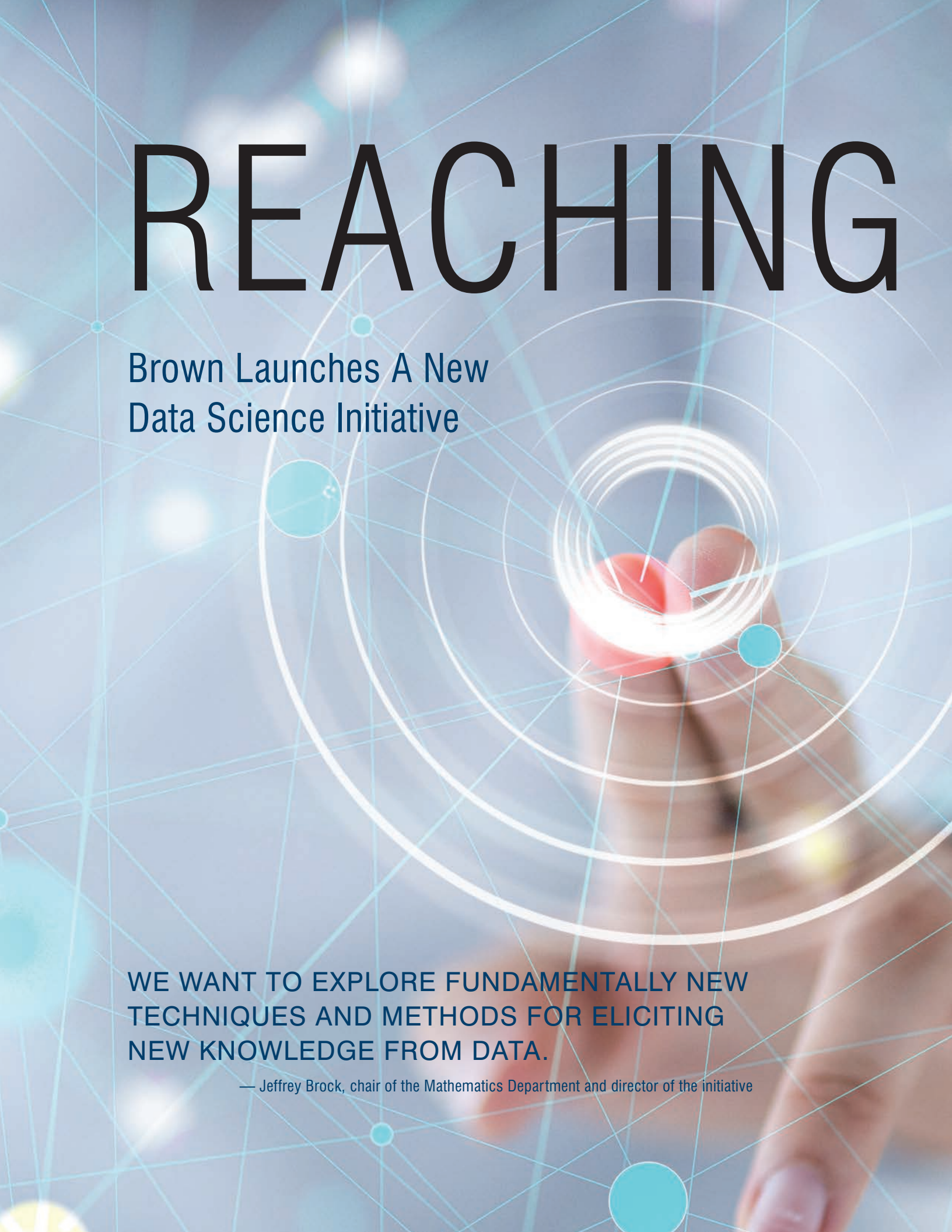
Left page // John meets with President of Dalat University Nguyen Duc Hoa and his party, including the founding president of Dalat, Tran Thanh Minh

Right page, top to bottom //

John meets with faculty, students, and Professor Nguyen Duc Hoa, President of Dalat University

On the red carpet at the Presidential Palace of Vietnam, from right to left: John, Nguyen Anh Tuan of Boston Global Forum, Vinh Vu of Vietnam Report, and Nguyen Thi Lan Anh of VietNamNet

John at dinner with the past governor of Ben Hoa Province; Professor Nguyen Van Ket, Vice President of Dalat University; Tuan Nguyen; and local dignitaries



REACHING

Brown Launches A New Data Science Initiative

WE WANT TO EXPLORE FUNDAMENTALLY NEW TECHNIQUES AND METHODS FOR ELICITING NEW KNOWLEDGE FROM DATA.

— Jeffrey Brock, chair of the Mathematics Department and director of the initiative

OUTWARD

Brown University has launched a Data Science Initiative to catalyze new research programs to address some of the world's most complex challenges and provide students with innovative educational opportunities relating to "big data". The initiative builds on established strengths in mathematical and computational sciences and a long history of data-related research across its core academic departments.

"From deciphering disease and improving the delivery of health care, to modeling climate change and evaluating public policies, Brown faculty are already on the cutting edge of the big data revolution," said Brown President Christina Paxson. "The Data Science Initiative will build on that tradition and unearth new methods for using big data to solve big problems."

Despite recent advances, growth in the volume and complexity of data continues to outpace the development of new techniques needed to translate these data into cutting edge research. At the same time, the application of big data to new questions and disciplines requires novel approaches.

In its initial stages, the Data Science Initiative will include a new one-year Master's degree in data science, expanded undergraduate course offerings, and the addition of ten new faculty members and researchers whose research and teaching will focus on fundamental methods of data science and their application to a variety of research questions.

The Data Science Initiative aligns with Brown's commitment, as articulated in the University's Building on Distinction strategic plan, to taking an integrative approach to developing solutions to complex challenges — an approach that bridges and unites multiple academic areas of research and study. Brown's departments of mathematics, applied mathematics, computer science

Above // Jeffrey Brock, chair of the Mathematics Department and director of the initiative

and biostatistics will serve as the initiative's hub, but a key focus will be to create a campus-wide community in data science, engaging students and faculty in life and physical sciences, social sciences and the humanities.

Ultimately, the initiative aims to ensure that scholars across Brown's disciplines become fluent with data in a way that encourages them to integrate data science into their teaching and research in novel and creative ways.

"Different types of data —genome sequences, data from social networks and medical records, to name just a few— are giving rise to entirely new frameworks and theories on how to extract meaning from data," said Jeffrey Brock, chair of the Mathematics Department and director of the initiative. "We want to explore fundamentally new techniques and methods for eliciting new knowledge from data."

Innovative Research

In addition to more traditional research projects in the life, physical and social sciences, scholars from the Data Science Initiative will work with Brown's Cogut Center for the Humanities to seek new connections across the cultural divide between the sciences and humanities and ways of using data in new scholarly contexts.

Partnerships with Brown's Watson Institute for International and Public Affairs and the Center for the Study of Race and Ethnicity in America will investigate the societal and cultural impacts of data, including questions related to data access, privacy, security, equity and justice.

"As the use of big data expands in commerce, public policy and in our everyday lives, it presents new challenges that cut across disciplinary boundaries," said Brown Provost Richard M. Locke. "Brown's Open Curriculum and collaborative research ethos put us in a unique position to help chart the future of the data-enabled society."

Each new research program arising from the initiative will build upon a history and tradition of data-related research in the initiative's core departments.

In the mid 1970s, a distinguished group of Brown faculty formed the Pattern Theory Group in Applied Mathematics. That team's work in the early stages of image processing, computer vision, the theory of artificial neural networks and other areas established foundational data manipulation techniques widely used today.

Computer scientists at Brown are developing new algorithms and machine learning techniques for automated analysis of large datasets that may include

text, audio, video and other types of information. Scholars are also creating new types of systems for manually searching, manipulating and visualizing data. Roboticists are using crowdsourcing and other big data techniques to increase the capabilities of robotic technologies.

The Department of Mathematics has research strengths in topology, geometry and graph theory, areas of pure mathematics that have found new application in data science. These techniques use the "shape" of datasets to identify clusters indicative of, for example, hubs in a social network or subtypes of a particular disease. These strengths complement those in harmonic analysis and cryptography, already central areas of data-related expertise.

Biostatistics faculty have leveraged data to create better screening protocols for lung cancer and public health strategies for preventing HIV spread. Researchers help to process genomic data to look for the mutations that drive cancer, as well as leveraging various datasets for precise and personalized treatment of individual patients.

"Building outward from these core departments, Brown will engage with the foundational questions of the data revolution, becoming a lighthouse for methodological innovation in data science," Brock said.

Educational Opportunities

The management consulting firm McKinsey & Company estimates that by 2018, the U.S. will have a shortage of 1.5 million managers capable of using data analysis to make informed decisions. There will be an additional shortage of as many as 190,000 employees with deep data skills necessary to develop complex analyses and communicate findings through visual media.

To prepare students for the data-enabled economy, faculty in the Data Science Initiative will partner with departments across campus to create data science course sequences to promote data fluency in students studying in a variety of disciplines. New faculty added through the initiative will expand the course options already available at Brown. Current course offerings include two introductory courses —"Data Fluency for All" in Computer Science and "What's the Big Deal with Data Science" in Applied Math— both designed to introduce the field to students without much experience with data science techniques.

“WE WANT THE DATA SCIENCE INITIATIVE TO BE A PLACE WHERE THOSE CONNECTIONS ARE MADE.”

The master’s program, which began recruiting its initial cohort this month, will offer a deeper dive into the methods applied by data scientists. In addition to a core curriculum focusing on foundational mathematical and computational techniques, an elective class will let students explore particular applications of their choice. A capstone project will help students apply what they’ve learned to real-world questions and problems.

“The program aims to provide students with the deep data fluency necessary for leadership in data-centric careers,” said Carsten Binnig, adjunct professor of computer science and director of the master’s program. “Courses will provide a fundamental understanding of the tools of data science that students can apply in a huge variety of careers, whether in business, health care delivery, academic research or something else.”

In both the educational and research mission of the Data Science Initiative, Brock said that collaboration across the disciplines will drive the initiative as an overarching theme.

“You never know when a technique applied to a data problem will be useful in another,” Brock said. “An approach used by one of our physicists sifting through the data produced by the Large Hadron Collider could be helpful to someone who is looking at data on how people behave in an economic market. We want the Data Science Initiative to be a place where those connections are made.”

Mosaic+ And Brown CS

Launch A New Program To Help URM Students Transition To Studying CS

According to Jonathan Powell, who recently finished leading the new Mosaic+ Transition Program, which helps underrepresented minority (URM) students prepare for studying computer science at Brown University, his experience as a new CS student was shared by many of his peers.

"I was interested in the program," he says, "because I heard a lot of second-year URM students talking about the struggles that they'd had. The academics were part of it, but even the small things, like finding where labs are and setting up your account, they're all barriers. CS has a fundamentally different learning curve, and it starts very early. For many students, their experience in high school helped build fundamental skills in math, writing, and other areas that they need for college courses. But for computer science, very few schools have a curriculum that helps build that foundation. That's what we're trying to do."

In the spring of 2015, Mosaic+ began working on what they call a "two-tier solution centered around the social and academic issues" faced by URM students: a Transition Program that would take place just before their arrival at Brown, and a Mentoring Program that would continue afterward. According to Mosaic+ co-coordinators Nifemi Madarikan and Chelse Steele, the student organization "seeks to equip these students with the resources, skills, and support structure that will allow them to thrive at Brown and become the next generation of computer scientists from the moment they step onto campus".

Top to bottom //

Mosaic+ and Catalyst students visiting the Boston Museum of Science

Mosaic+ Facilitators Ebube Chuba '19 and Joanna Simwinga '18 with Parielle Lacy '15 after her talk with students on how to succeed at Brown

Arthur Borem '19, Stephanie Alvarado '19, Auriane Benabou '19, Jake Staton '19, and Gus Stephens '19 excitedly waiting to tour the Google Boston office.

A great deal of research followed. With assistance from Department Chair Ugur Cetintemel, Vice-Chair Tom Doeppner, and Professor Shriram Krishnamurthi, Mosaic+ studied programs at University of Michigan, Stanford University, and other schools to find models of engagement and useful best practices. They also partnered with Brown's New Scientist Catalyst summer program, which helps incoming URM students in science, technology, engineering, and math, but doesn't focus on CS.

"It was really Chelse and Nifemi's brainchild," says Laura Dobler, the Brown CS Financial and Outreach Coordinator, who works extensively with Mosaic+ on diversity-related initiatives. "The Transition Program is a comprehensive solution for so many different types of problems. For URM students, it's not just about helping them past the learning curve of doing research, it's about creating a community, leveling the playing field, providing mentors and resources, and doing everything we can to make their experience more typical."

Thirteen students arrived in August as the program's first cohort. Their mornings were spent on the Transition Program's technical curriculum, designed to introduce them to functional and object-oriented programming concepts, build technical skill, and expose them to various CS applications. It included lectures, tech talks and demos, labs, and problem sets, culminating in the creation of a unique app.

"We wanted students to create something they could really use," Jonathan explains, "to learn about databases and JavaScript but have a product at the end and an 'I made this' moment." Many volunteers contributed to the effort, with Shriram, Elbert Wang, and Abdul Raziq Tabish playing a key role by developing the curriculum and the online instructional component. Jewel Brown and Ebube Chuba both gave talks on student groups, academic technology, and interdisciplinary possibilities with computer science. Purvi Goel created a Pokémon Go-inspired augmented reality tour of the CIT, and Joanna Simwinga documented the entire program, taking pictures and providing support.

Afternoons provided a bit of a break in the form of the non-technical curriculum, which prepared students for other aspects of academic life, such as Brown CS culture and campus resources. Field trip destinations included the Boston Museum of Science, the Google headquarters in Boston, and New Hampshire's Mount Monadnock. Jonathan credits Laura as well as Lynsey Ford of the Science Center for the "administrative acrobatics" of many emails sent, phone calls made, and releases and waivers tracked down.

"It was really a success," he says. "Even as we were doing it, we were thinking of things to do differently next year, like making sure that we have all the faculty members who teach intro courses join us as speakers, but I'm proud that we not only covered things like programming and coursework but also gave students the full set of skills they need to do well."

"This is Mosaic+ really giving back to the next generation," Laura adds. "It's a wonderful thing to be a part of." In the future, Brown CS is hoping to build on the success of this program by extending it or creating similar programs for students from other historically underrepresented groups (HUGs) as well.

"I'm grateful to everyone who jumped in with their spare time and engaged with our participants," says Jonathan. "The students told me again and again how much they valued hearing about our experiences and seeing a community designed just for them start sprouting up around them. Now, with the Mentoring Program getting started, we're going to take that skill-building and support to a whole new level."

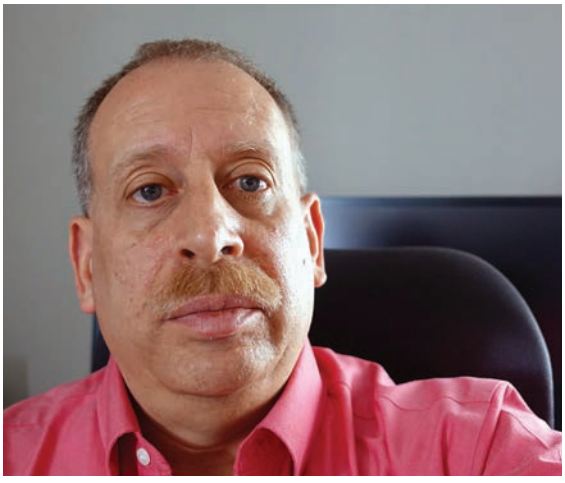
"The students told me again and again how much they valued hearing about our experiences and seeing a community designed just for them start sprouting up around them. Now, with the Mentoring Program getting started, we're going to take that skill-building and support to a whole new level."

Making The Future Happen:

The Brown CS Undergraduate Teaching Assistant Endowment

As we go to press, Brown CS is only $1.5 million away from reaching the goal of a $10 million UTA Endowment to ensure that this important program thrives for generations to come. The campaign's web site, featuring testimonials from UTAs past and present, is at www.cs.brown.edu/giving/uta. Below, Norm Meyrowitz, the Campaign Chair, shares an update.

Hi All:
It's been a bit over a year since we launched our crowd-funding campaign to raise a $10 million endowment to support the UTA program in Brown CS. We've had a great response from alums stretching over 50 years, with donations big and small. It's rewarding to see how much the UTA program has meant to so many people over such a large span of time. A huge thank you to all who have donated.



Above // Norm Meyrowitz '81

I'm happy to report that we've hit the $7.5 million mark in pledges! And we've been given a challenge by a very generous CS alum. When we hit $9 million, he'll put in $1 million to complete our campaign. Using sophisticated computational methods, I've determined that we only have $1.5 million left to raise!

You've probably already figured out that this paragraph is going to talk about raising the remaining sum:

- If you haven't yet contributed, please help. No amount is too small (or too large). ;-) We'd love to have maximum participation.
- If you've contributed, we're extremely appreciative. And if the spirit moves you, feel free to contribute again!
- A bunch of people are creating UTAships honoring a person or a group.
- A bunch of companies are creating UTAships named for the company for $50K.

Please spread the word to all your friends, classmates, and company colleagues. Some have likely already given, but some would be grateful for a reminder. The website for contributions is: https://cs.brown.edu/giving/uta.

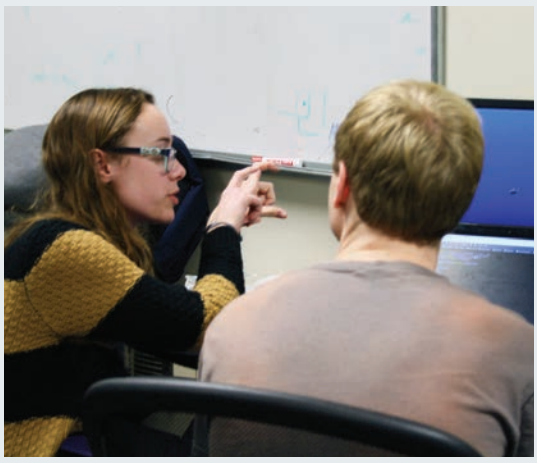
Now for an update of how the UTAship program is going: 21 UTAships have been awarded for first semester, and another 14 in the second semester. This page (https://cs.brown.edu/giving/uta/scoreboard) lists all the funded UTAships, both present and future, and this one (https://cs.brown.edu/courses/ta) lists the UTAships assigned this year.*

I personally can attest to the personal gratification one can get from donating for one of the UTAships. I pledged one of the two MetaUTAships (the two students who coordinate UTAing amongst all of the classes). It turns out that this year it was awarded to Emma Herold, who through happenstance is the daughter of Bob Herold, one of my TAs in the late 70s! And I recently learned that one of the MetaTAs for next year, Alyssa Baum, is the daughter of Andrea Terzi Baum, for whom I was a TA. While this is unlikely to happen often for me or any donors, it illustrates the bond that the UTA program forges between graduates from all 50+ years of Computer Science at Brown.

The folks in CS and in University Hall are extremely appreciative of how fast we've stepped up to this challenge and how much we've raised in such a short period of time. We're almost there — it's crunch time, and as CS majors, that's when we do our best.

Thanks for all you have done and will do,
Norm

Norm Meyrowitz '81
Chair of the Brown CS UTA Endowment Campaign



* The UTAships become awardable as soon as 20% of the contribution has been received. (If you're doing the math on how many TA's 1/2 of $7.5 million would yield, you'll see that we theoretically should have been able to award more — the discrepancy is that we're waiting for the first 20% to come in.)

** It's worth considering the deduction value of a contribution. The full value of the donation is tax deductible. If you have appreciated stock, you get a double benefit — not only do you get the deduction of the full value of the donation, you also don't have to pay capital gains tax. This can lead to a considerable lowering of the "cost" of the donation.

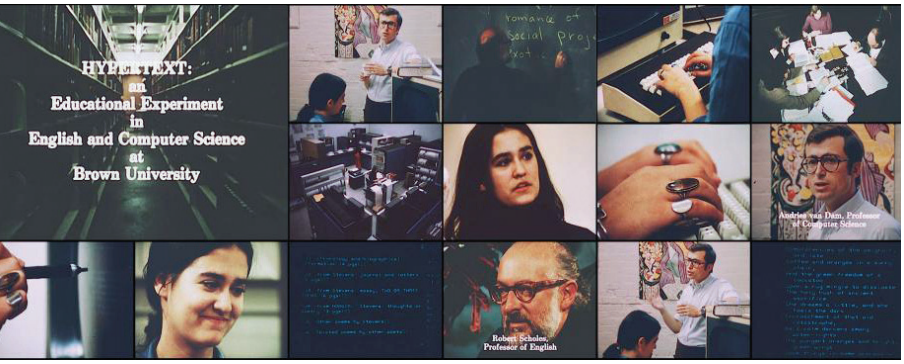
Where Meter Meets Mainframe:

AN EARLY EXPERIMENT TEACHING POETRY WITH COMPUTERS

by Kevin Stacey (Science News Officer, Physical Sciences)

In the early 1970s, two Brown University professors devised a radical idea for the time. English professor Robert Scholes and computer scientist Andy van Dam wanted to use Brown's room-sized mainframe computer to teach a course not in physics, engineering or computer science, but in poetry.

The idea doesn't sound so revolutionary now, in an era when computers are everywhere and can help people to do nearly anything. But some 45 years ago, Scholes and van Dam met with resistance. Many in the humanities thought it folly to try to explore the deeply personal experience of poetry in silico. Experts on the technology side — including the gatekeepers who allocated precious time on Brown's mainframe — thought poetry was an improper use for the machine.



Top // Andy van Dam lecturing in the 1976 film

Bottom // The title card and other moments from the film

"There was a cultural attitude that said that computers were for number crunching," said van Dam, the Thomas J. Watson, Jr. University Professor of Technology and Education at Brown. "The idea of using a multimillion-dollar mainframe for manipulating text was hard for scientists and engineers to swallow."

But van Dam and Scholes pressed on, eventually getting their computer time, as well as a grant from the National Endowment for the Humanities (NEH) to help administer the class and evaluate its effectiveness.

Late last month as part of the NEH's 50th anniversary celebration, a group of scholars and NEH leaders including the director, gathered at the University of Maryland to discuss the project and its legacy. The event included a screening of a short documentary film about the project made in 1976 that hadn't seen the light of day in decades.

Parts of the film, which was recently digitized and is now available online, seem as quaint as one might expect from a film about 40-year-old computing technology. There are plenty of shots of room-sized computers, large magnetic disk drives and green-and-black monitors with telephone receivers affixed to the top.

But the project itself seems to have had an uncanny prescience.

"I really believe that we built the world's first online scholarly community," van Dam said in an interview. "It foreshadowed wikis, blogs and communal documents of all kinds."

The course was organized to create new ways for students to interact with texts, their instructors and each other. Units centered around a single poem, which students could scroll through on a mainframe terminal. Sections of the central poem were marked by descriptive "tags" used for searching that we would call hyperlinks today. Students could select these links to find critical reviews, related poems or other supplementary and contextualizing material. Students could also add their own thoughts and commentary into the system — all of which would then be available to their professors and classmates through new links from the central poem.

In the documentary, van Dam describes the approach as a means for students to contribute to a "creative graffiti." The idea was to create "a new kind of community with professors and students working together to develop a true process of learning."

To see if that process actually helped students learn, van Dam and Scholes approached the project as a formal experiment, placing students into two experimental groups and a control group. One group took the computer-based course, while another group used paper versions of the same materials. The control

group took the same course in a traditional classroom setting.

The project showed that the computer group came away with the deepest understanding of the material and the highest satisfaction with the course. It also created a lively dialog between students, instructors, professional critics and the texts themselves.

"One of the things that we saw is that people gave roughly equal weight to their classmates' and their instructors' opinions as they gave to the professional critics," van Dam said. He attributes that to the fact that all of the commentary from professional critics and classmates alike looked the same on the screen. There was no fancy typeface to give the appearance of professional heft. As a result, students weren't intimidated by or overly reverent of the professional critics.

"It was a leveling," van Dam said, "a democratization."

But perhaps the most important outcome — certainly the outcome that was critical to Scholes as an English professor concerned with the decline of student writing — was the fact that using the computer encouraged students to write more. On average, the students in the computer-based group wrote three times as much, however informally, as the students in the other groups. Van Dam attributes that outcome, at least in part, to the ease with which the students could compose their thoughts in the software system used in the course.

The system was dubbed FRESS, which stood for File Retrieval and Editing System. However, the name was not originally an acronym — van Dam added that later. Initially, the name came from the Yiddish word "fresser," meaning a gluttonous eater. FRESS gobbled up a quarter of the Brown mainframe's 512-kilobyte memory capacity at the time.

Van Dam developed FRESS in 1968 with the help of mostly Brown undergrads and a few master's students. It combined word processing with the creation of hypertext — text with links to other texts. It was the successor to the Hypertext Editing System that was developed by van Dam and Ted Nelson, coiner of the term "hypertext."

"From the beginning we wanted FRESS users to be both readers and writers, consumers and authors," van Dam said. "So the fit to the poetry course was perfect."

FRESS had many attributes of a modern word processor. The system made it possible for users to move a cursor to different parts of a document and use commands to add, delete or move text. There was an additional feature — now ubiquitous in modern word processing — that van Dam is particularly proud to have developed for FRESS.

"We had, I believe, the world's first 'undo' [command], which for me is the most important element of any system," van Dam said. "It's critical because it takes the fear of experimentation away. You can always just undo it."

The development of FRESS has other very direct connections to modern word processing. One of van Dam's students who worked on the development of FRESS would go on to be a program manager for Microsoft Word 1.0.

But van Dam and Scholes had little of that in mind when they created their poetry course. They simply set out to show that digital technology had a place in the humanities and that an understanding and appreciation for poetry could be aided by streamlined human-computer interaction.

By that measure alone, the project was an unqualified success, van Dam said.

"We learned that students gain a tremendous amount of insight from having vast amounts of information at their fingertips."

"I really believe that we built the world's first online scholarly community," van Dam said in an interview. "It foreshadowed wikis, blogs and communal documents of all kinds."

Computational Ideas, World Culture, And Maximum Insights Per Hour

Donald Knuth Delivers The 2016 Paris C. Kanellakis Memorial Lecture

Among many other things, the visit was timely: a post about Donald Knuth's multi-volume opus, *The Art of Computer Programming*, was trending on Slashdot just a week after his visit to Brown.

On Thursday, December 1, 2016, and Friday, December 2, Brown CS hosted Knuth, Professor Emeritus at Stanford University. Widely regarded as an artistic genius and perhaps the most gifted programmer of all time, he delivered the 16th Paris C. Kanellakis Memorial Lecture and a John von Neumann Lecture.

"This is the most mind-boggling thing," Knuth said at the start of the first lecture, and then proceeded immediately to boggle the minds of a record-size audience with insights that varied from the specific to the far-reaching and from the offhand to the profound. Below, we sketch just the outline of his visit in text, photographs, and video.

ORGAN MUSIC

The mornings of both days were occupied by visits to two prominent local pipe organs, one at Brown's Sayles Hall and the other at the Cathedral of Saints Peter and Paul. Knuth played a selection of Bach, seasonal favorites, and part of his own *Fantasia Apocalyptica*, which he described with enthusiasm and a vocabulary more reminiscent of an undergraduate than an octogenarian: "So far, I'm psyched about it!"

Explaining the mechanics of a pipe organ to his listeners, he made the computer science analogy of columns and rows, saying that there are *n* notes and *m* tonalities to choose from, and thus the total number of sounds that the organist can possibly make is at most 2 to the power *m*-plus-*n*. However, the number of pipes is *m* times *n*; therefore, if a computer were able to turn each individual pipe on or off independently, the organ would be able to produce many, many more sounds: 2 to the power *m*-times-*n*!

For example, at Sayles Hall both *m* and *n* are less than 70, so fewer than 2 to the power of 140 sounds are possible. But that organ has 3355 pipes, so it's capable of 2 to the power of 3355 different sounds. Thus, Knuth mused, for every sound the organist can play, the instrument is actually able to make more than 64,000,000,...,000 (imagine 957 other zeroes in the expression) others. "Most of the sounds this instrument can make haven't been heard yet," he said. "We don't know if the unheard ones are beautiful or not. Are we missing something important?"

Left page // Donald Knuth playing the organ in the Cathedral of Saints Peter and Paul

Top Left // Donald Knuth, Eli Upfal, and Sorin Istrail in Sayles Hall

Top Right // Sorin Istrail, Donald Knuth, and Richard Stanley of MIT

HAMILTONIAN PATHS AND SATISFIABILITY

Both lectures were spectacularly well-attended, setting Brown CS records. Introduced at one point by Professor Sorin Istrail as one of "two real-life superheroes, von Neumann and Donald Knuth", and wearing the same brightly-colored shirt from when he spoke at the opening of the CIT in 1988, Knuth seemed to relish speaking to what he described as a "pretty geeky" audience.

The first lecture, which Knuth framed as a "history of clever ideas that arose around the world", traced the evolution of a problem that dates back to antiquity: finding a path that encounters all points of a network without retracing its steps. Knuth's sense of aesthetics, curiosity, and his love of minutiae and the absurd were on full display ("look at the ingenious wordplay.… nonsense things like this are easy to learn") as he took his audience from Hellenic icosahedrons to a knight's tour of the chessboard to the sandals of Lord Rama, mentioning with offhanded modesty feats such as teaching himself enough Sanskrit to find errors in Wikipedia entries devoted to obscure treatises half a millennium old.

In the second lecture, Knuth returned the audience to his multi-decade project, *The Art of Computer Programming*. ("It makes a wonderful Christmas present," he said to considerable laughter.) His subject was the concept of satisfiability, in which a formula is declared satisfiable if one can find and prove a model that makes the formula true. Again, the approach was in part historical, tracking inflection points such as the "unseen breakthrough" of lazy data structures in 1982, but Knuth also made an argument for the importance of what he described as a "million-dollar" problem. (The number refers to the value of the award given by the Clay Mathematical Institute for solutions to their Millennium Prize Problems, some of the most famous unsolved questions in mathematics.) "I didn't anticipate," he said, "that I was going to have 300 pages on it, but eventually I realized that satisfiability is a basic technique that deserves to be much better known, part of every programmer's toolkit."

The occasional digressions were equally interesting. Knuth explained that creating a graph of character interactions in *Anna Karenina* increased his appreciation of Tolstoy, and that he obtained "maximum insights per hour" through a technique of taking a random walk through the Bible as well as through student papers that he needed to grade. "Some people thought I graded at random," he joked. "That wasn't *exactly* true."

KNUTH AND WEGNER

At the end of the first lecture, Sorin offered a champagne toast to celebrate a remarkable collaboration between Knuth and Brown CS Professor Emeritus Peter Wegner. Almost fifty years ago, Knuth

explained, a "hot topic in those days" was the hope to "define the precise meaning of programs in a formal way, noting that all of the existing proposals for programming language definition at the time were too uncomplicated and unintuitive to be fruitful".

During a visit to Wegner's home in 1967, Peter suggested that information could be conveyed down a parse tree as well as upward from the bottom. This seemed preposterous at the time, Knuth explained, sharing the memory of how he was so agitated by the idea that he suddenly realized he was yelling instead of speaking in a normal tone. But the suggestion lingered in his mind because he understood that Peter was absolutely right. This suggestion soon led to the invention of attributed grammars. "Much of the technology of modern compilers," write Shasha and Lazere in *Out of Their Minds: the Lives and Discoveries of 15 Great Computer Scientists*, "dates from these insights."

QUESTIONS ANSWERED

After each lecture, when students asked a variety of difficult, far-reaching, and even unanswerable questions, Knuth shone. The witticisms were present again as he answered a query as to whether a supreme deity plays dice with the universe ("God could perfectly well play dice, if that leads to a good algorithm"), but weight and seriousness returned as he urged attendees to lengthen their attention spans. "Computer science shouldn't automatically lead directly to Wall Street," he said; computer scientists should "advance civilization" instead.

Not even the most broad and fundamental challenges were out of bounds. When asked about what's widely considered the most important question in computer science theory, Knuth took the unpopular position that *P=NP*, giving just enough detail in his response to preserve and even augment, rather than destroy, the mystery of one of the most famous problems of our discipline.

Some of Knuth's most powerful moments were when his remarks took on the fullest possible global and cultural scope: "The notions that we now think of as computational ideas are part of world culture going way back." Each time, whether the topic was look-ahead solvers, random sampling of the Bible, or the "thrill" of feeling like he was talking to a fellow scholar from the 13th century, segments of the talks devoted to theory and comprehensive detail were illuminated by the personal example of Knuth's intellectual restlessness and eagerness, his unabashed love of experimentation. Even as he lamented that he was unable to persuade any of his PhD students to interest themselves in the history of computer science, he urged his audience to do so, and thereby pursue the life of ideas: "We need to see what other people have thought and how they approached problems, a combination of breadth and depth….good computer science, like good mathematics, has a long half-life."

Left to Right // Knuth evaluating his options at the Cathedral of Saints Peter and Paul

Sorin Istrail, Ugur Centintemel, Jill Knuth, and Donald Knuth

Donald Knuth delivering his John von Neumann Lecture

Evgenios Kornaropoulos, Alexandra Papoutsaki, Peter Wegner, Donald Knuth, Manolis Kellis, and Christos Kapoutsis

Photos And Videos

For a full gallery of photos from Professor Knuth's visit, go to: http://bit.ly/2i6VcH7

For links to videos from the two-day event, go to the bottom of the news item here: http://bit.ly/2iw9BQ8

Brown CS Welcomes Theophilus Benson, Kathi Fisler, George Konidaris, Daniel Ritchie, and James Tompkin

Theophilus Benson

Theophilus ("Theo") Benson is joining Brown CS as Assistant Professor in September, and if you see him out on a run, training for his next Tough Mudder, consider joining him for at least a block or two. He's always eager to discuss recent IoT security challenges, cloud outages, and performance issues.

Theo's introduction to CS dates back to the era when cloud computing was only possible in science fiction: "I remember there not being a lot of color and complexity on the computer screen. Back then, it was so much simpler to find out how things worked." His interest in the field continued through high school, but an early job at a startup, doing testing and development, systems engineering, and release engineering, provided additional momentum and a definite direction for Theo's career. "One day," he remembers, "I got paged because the sysadmin was out sick and the server had gone down. I understood the release process, so I thought I'd just reboot and things would be fine. The problem was that some of the process had been documented, but part hadn't, and a lot had to be inferred. Not quite as easy as I'd thought!"

"And that got me thinking about the broad space of networking," he says, "and how to take humans out of the loop when they're going to cause errors or slow things down. The problem is, we don't want to be taken out of it!"

In graduate school at University of Wisconsin, Theo focused his attention on the intersection of networks and security, using the tool of configuration management, a process that analyzes the requirements, design, and performance of a network to improve the consistency of its performance. "Configuration management is a huge challenge due to competing economic interests," he says. "There can be a lot of animosity when sysadmins think that we're taking away their jobs, but we're really just trying to minimize the time they spend on certain tasks." He gives the analogy of going to the doctor: patients describe their symptoms but don't diagnose their own illnesses.

Despite industry experience that also includes AT&T and Microsoft, academia has always felt like home: "There's a lot more freedom to attack problems. In the corporate world, when a new buzzword arrives, everyone switches over because it's the next big thing. I like the wide scope of interests at Brown CS. Instead of being in a silo of networking experts, I'm surrounded by different perspectives."

When we ask Theo about the outreach efforts listed on his web site (among other things, his research group has allowed high school students to collaborate with them during the summer), his answer is refreshingly free of platitudes. "That experience was very valuable to the students," he says, "but I don't feel like I'm being helpful enough. As long as we're interacting with students at their level, it helps, but getting outreach

right isn't easy, and I'm still trying to figure things out. A lot has been given to me, so I feel like I need to do more."

He'll have a chance in Providence, where he's looking forward to being physically closer to both family and colleagues in the area. Part of the Brown CS appeal, he explains, is that he'll be working alongside experts in software-defined infrastructure, programming languages, and the Internet of Things, not just networking. "We'll amplify each other," Theo says. "And I've heard great things about the undergrads and how they take a huge amount of initiative in jumping in with research. I want to see what we can do together."

Some of the research possibilities include the area of software-defined networking, which he sees as going through a major paradigm shift. "There's going to be a whole new level of automation," he says. "Instead of transplanting network protocols designed for Google to developing countries, where there are huge infrastructure discrepancies, we'll have algorithms that can learn about local conditions and adjust, networks that are able to learn by themselves."

"It requires us," explains Theo, "to question assumptions about what works and what doesn't." It's part of what appeals to him about the work of Ion Stoica, whom he cites as one of his heroes. "I always looked up to his work with Spark, which really impacted the way big data interact with networks." In the end, he says, meaningful computer science speaks for itself far better than becoming a household name. "When you have that much impact, that's what people remember. They may not know your name, but if it works, it works!"

Kathi Fisler

One way to think of Kathi Fisler's career, she says, is that it's been a constantly shifting balance between formal systems (and how they work) and people (and how they learn). For years an Adjunct Professor at Brown CS, she's just been appointed Professor (Research) and Associate Director of the Undergraduate Program. It's a momentous shift toward the latter half of that balance, letting her focus on CS education for both K-12 students and Brown ones. "This is deeply personal to me," she says. "There's an opportunity, a challenge, and it's just a fun playground for me to work on connecting people with computer science."

The main reason why the challenge of CS education has a personal dimension for Kathi originates in her first year at Williams College. Only intending to focus on mathematics and Asian studies (Chinese in particular), she was required as a math major to take CS 1. "I wasn't very good at it, and it drove me nuts, instructing a hunk of metal and having it be totally my fault when something didn't work." Fisler gestures toward an empty spot on her desk as if the offending computer were right in front of her. "I didn't fail, but I didn't do well, either."

Determined to prove that she could conquer programming, Kathi signed up for CS 2. By the mid-term, she was failing. But thanks to many office hours spent with a supportive faculty, she kept going: by two-thirds of the way through the year, her grades had soared, and early in CS 3, she realized that she enjoyed CS more than math. "This is one reason why I love CS education, particularly introductory courses. I deeply understand when it doesn't work, and I know how it feels to power through the learning curve that many students face. I was the only newbie, the only woman across 3 consecutive years of CS majors. Nobody would have been surprised if I'd walked away from computer science, but thankfully I was too stubborn to do that and my brain soon caught up."

Traveling to University of Indiana at Bloomington for her Master's and PhD, Kathi envisioned studies in computational linguistics, but was waylaid by a hardware design course. A new research lab was starting up, and she jumped at the chance to do work that touched on math, computer science, and even philosophy: examining how people reason with diagrams, particularly in hardware design. "Traditionally," she says, "mathematical proofs were largely written in text form, and diagrams weren't considered rigorous. Why is that? Think about a civil engineer, who uses math and modeling instead of sending cars over an unproven bridge to see whether it collapses. Why can't we use diagrams to reason about how a system will work?"

This line of inquiry led to research in verification techniques, and later to access control policies and their security implications. "Every problem I studied," says Kathi, "kept coming back to the question of how humans understand a question involving computational systems." She gives the example of Facebook privacy settings, which many people believe they understand fully, yet have resulted in numerous privacy leaks when reality didn't match someone's conception of how things worked.

> "I have a CS education team with decades of experience, deep programming language expertise, and everyone under one roof. Anywhere in the world, that's incredibly hard to find"
>
> - Kathi Fisler

"When you have people trying to use systems successfully," she says, "people are the difficult part. I really want to understand what's going on for them cognitively, psychologically, how they learn." More than twenty years ago, that was part of the motivation for work that led to Bootstrap, a family of curricula that integrate computer science with other disciplines in K-12. Initially a "side hobby" for Fisler and her long-time collaborator, Professor Shriram Krishnamurthi, it's now used by roughly 15,000 students per year across 17 states and five countries.

CS education has been in the news a lot lately, but what has Kathi seen in her years of research that the layperson may be unaware of? "It's taken years to realize how much we don't understand, how many concepts are packed into a simple programming task. The literature is overflowing with evidence that many people struggle to learn CS, and now we understand that we can't accept the idea that some people just won't be good at programming as an answer. Computer science is a form of literacy for everyone now: there are economic and equity issues. If we preach CS for all, we need to accept that everyone isn't going to be a computer scientist, and think about what we teach and how we teach it."

For years, Kathi has divided her time between being a Professor at Worcester Polytechnic Institute (WPI) and an Adjunct Professor at Brown. Recently, her juggling act (Bootstrap at Brown, research and teaching at WPI) has become unbalanced by Bootstrap's rapid growth, which made the opportunity to consolidate all three efforts hugely appealing. Brown offered not only the perfect job description but the chance to form an entirely in-house research group that has few rivals.

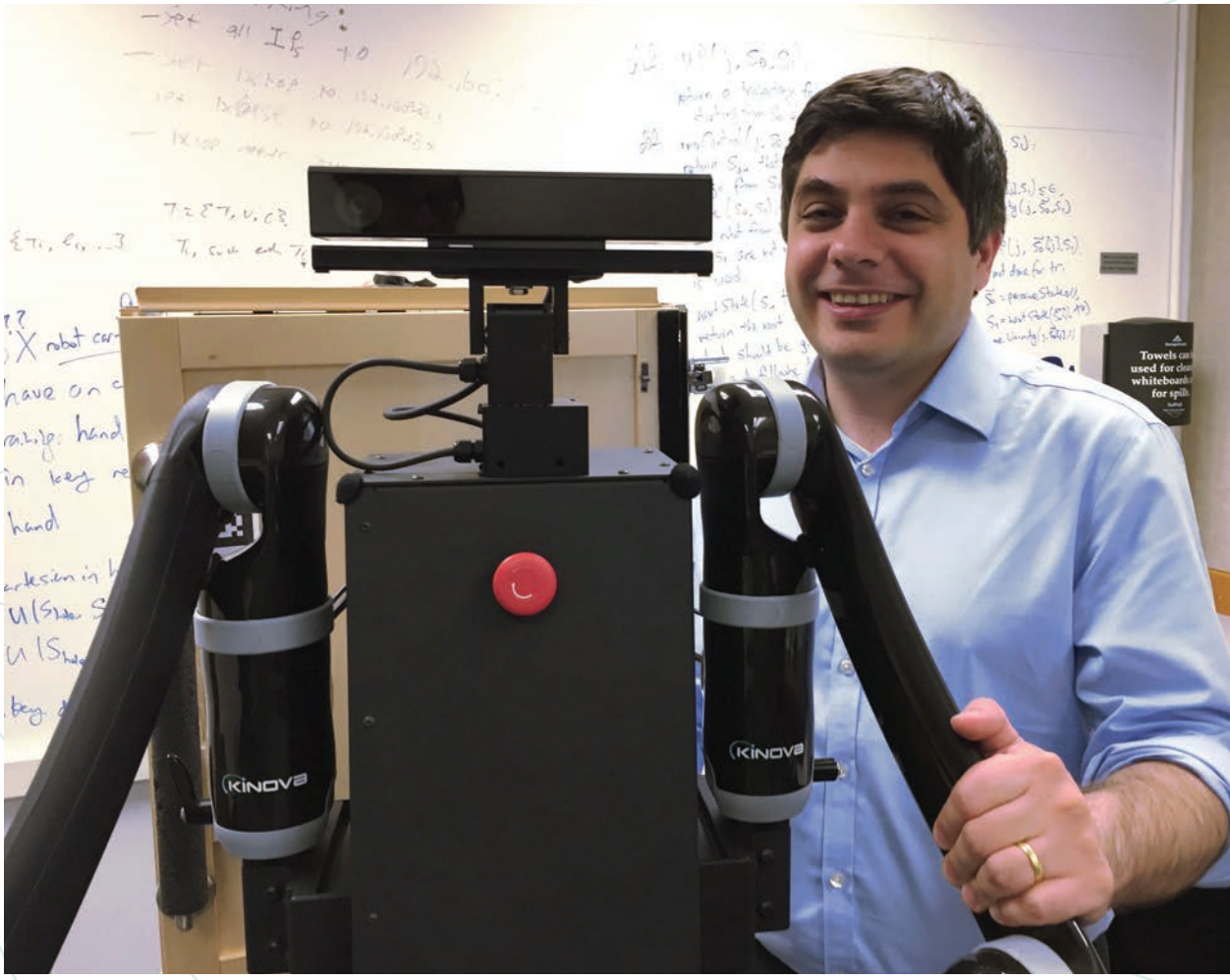
"This lets me focus," Kathi says. "I love advising and working with students for all the reasons that I've mentioned, and this lets me participate more fully with Bootstrap. Together with Shriram and the rest of the group, I have a CS education team with decades of experience, deep programming language expertise, and everyone under one roof. Anywhere in the world, that's incredibly hard to find." Giving up the commute to Worcester may also give Kathi more time for her hobbies, which include playing music, singing, running (she notes a theme of rhythm among all three), jigsaw puzzling, and cooking vegetarian food.

But not too much spare time. There are big challenges ahead, she explains: "We need to find out how to provide broad CS education before we lose another generation. We need to enable teachers who don't see themselves as computer scientists to introduce students to computing. This new role is my best chance yet to do the deeply personal work of taking everything that I've learned about systems, about learning, and to help the people who are facing one of the greatest educational tasks in history. I can work with a struggling college student at the same time that I'm looking out for an atypical learner in kindergarten or high school, and that's so important to me."

George Konidaris

For many of us, being handed a C++ compiler in high school would have been a difficult and inauspicious introduction to computer science. Not so for George Konidaris, who joined Brown CS as Assistant Professor last autumn: as a teenager, growing up in South Africa, he had mostly used computers for games, but the compiler looked interesting. "It was magical," he says of teaching himself to program. "It was a profound change for me, a mini-intellectual revolution. The world shifted half a degree on its axis. That's really where I learned how to think."

A love of research has spanned George's entire career, and as a teenager, the tools for seeking knowledge were close at hand. An older sister, having graduated with a joint degree in computer science and economics, no longer needed her textbooks. "I plundered them," says



George. "It was fascinating, and I became very serious about learning everything about computers that I could."

"Starting out as an undergraduate at the University of Witwatersrand in Johannesburg," he explains, "I was drawn to artificial intelligence." To Konidaris, it had the biggest, most interesting open questions.

George's social circle shared his interest in research. "Five of my friends from university ended up getting their PhDs overseas. We hung out every day, and we talked each other into the idea of studying abroad." He won a scholarship to do his Master's degree in the UK, and chose the University of Edinburgh for their strong programs in artificial intelligence but also robotics, which had been of increasing interest throughout his undergraduate years. After Edinburgh, his travels took him to the University of Massachusetts Amherst, where he earned his PhD, leaving him with four degrees from universities on three different continents.

What was the appeal of robotics? Konidaris sums up his thoughts with a simple statement that turns unexpectedly introspective. (It may also explain the ease with which he puts his arm around one of his own robots and smiles for a photograph.) "If the brain is a computer, and I think it is, then humans are robots."

Asked to explain his unbroken interest in research, George says that it's been interesting, fun, and turned out to be something he was "reasonably good" at. "When you look at the history of computer science, it's very inspiring. Its researchers are brilliant, just amazing people. And, in the space of a generation, they changed the world in a profound way."

Konidaris describes his own work as an attempt to design intelligent robots. "Robots have the fundamental problem of making plans and generating action when they're doomed to interface with the world at the level of the pixel and the motor. That's their reality. But to achieve more complex behavior, to do something like having a robot get to the right gate at an airport to catch a plane, we need them to be able to make abstractions, to plan using higher-level concepts. At the moment, it's more like they have to carefully plan every individual footstep and then struggle with things like recognizing what the right gate looks like when the scene has changed even a little bit. I'm interested in helping them gain the ability to reason and learn at the right level for solving the problem at hand."

He's in good company. George says that he's always wanted to work with faculty members like Amy Greenwald, Michael Littman, and Stefanie Tellex. "It was just too tempting! Brown CS is a great fit for me. It was a combination of things: a department that's really good at what it does, an outstanding place that's really friendly." Konidaris is eager to meet students as well. "A career in computer science can be a lifetime commitment," he says. "I hope people are looking ahead, not at just the next big thing but the long run. I think it's important for all of us to look back at the end of our contributions and see something that's been worthy of an intellectual lifetime."

Daniel Ritchie

Students who know about Daniel Ritchie's arrival (he's joining Brown CS as Assistant Professor in July) have already shared their excitement about his work in AI systems to enable creativity, generative models for graphics and design, and probabilistic programming. But given Brown's reputation for interdisciplinary study, they may be equally enthused about the need for creativity that runs alongside his love of research and experimentation.

"As a kid I thought I'd be a novelist," he says, "or work in music or film, the arts. Computer science started out as a hobby for me, and I didn't know where it'd lead. I didn't get serious about CS until college, and it wasn't until my internship at Pixar that I realized I could bring the two interests together."

As an undergraduate at University of California, Berkeley, Daniel studied computer graphics, working in physical simulations and developing an interest in applications that could be used in film production. Branching out into artificial intelligence and machine learning while in grad school at Stanford University, he

experimented with automatic generation of common 3D environments such as bedrooms and kitchens.

"I like bringing things to life and sharing them with people," he says. "The creativity of it always brings me the most joy." Looking to find some joy for our own playlists and Netflix queues, we press Daniel for recent favorites across various media, and he speaks with feeling about a band called Cloud Cult ("deeply personal, lyrics about loss and fear of the unknown"), an independent film called Short Term 12, and the works of Patrick Rothfuss, citing the author's world-building talent and ability to choose words with care.

Is computer science creative? "It absolutely is. No idea comes out of a vacuum, but new insights are required in order to make progress. Research isn't that dissimilar to design, or the artistic process: experiment, prototype, iterate, then check direction."

Broadly speaking, Daniel explains, his own research is about using artificial intelligence and machine learning to create content for graphics. "A lot of machine learning," he says, "is concerned with coming up with explanations for data that we have about the world: categories, structure, how it was created." Probabilistic programming, which repeatedly generates models, draws inferences from them, and then generates new ones, is a useful tool. Ritchie gives the example of using an algorithm to generate buildings, then automatically eliminating the ones that aren't stable: "It's reasoning backward from the goals that you want to satisfy."

"That was where machine learning really clicked for me," he explains. "The results are often surprising, which provides a lot of potential for inspiration." It's also democratic: "We're augmenting what the average person is capable of, automating away tedious details, guiding them back to good design."

With his PhD from Stanford now complete, Daniel is looking forward to his arrival at Brown and continuing his work with tools that will have a broad user base. "I want to get more people well-versed in artificial intelligence and machine learning methods, especially people who don't become AI/ML specialists....It's really satisfying to work with students who are just starting

out in their careers, who are ready for new ideas. I like how Brown CS is a community, not a collection of research labs. That's rare and special."

And what's next for his research? "There's been an explosion of deep learning technology," Daniel says. "I'm really interested in combining it with probabilistic programming. I'm also interested in exploring more applications for creative AI. For example, AI-assisted content creation tools in VR, or even applications beyond graphics, such as music composition."

Despite rapid technological advances, Daniel has little fear that humans are at risk of obsolescence: "Creative AI systems are powered by some combination of carefully coded design principles and learning from examples. But people had to come up with those design principles and create those examples in the first place! So these systems depend on people; in one way or another, they capture the best of what people know about how to create. When it comes to creativity, I'm a firm believer in augmenting human capabilities, rather than trying to automate them away. Creativity provides joy for people — why would you want to automate that away?"

James Tompkin

"We have responsibilities as scientists, and a need for rigor," says James Tompkin, who joined Brown CS as Assistant Professor last summer. But, watching a video overview of his recent research (https://www.youtube.com/watch?v=qphK1_fdJas), the areas of inquiry sometimes surprise. Sophisticated editing of image and video content, new interaction and display devices from light fields, and...animal-shaped glockenspiels? "There's also space for more fun," laughs James, "and for the understanding that people are human."

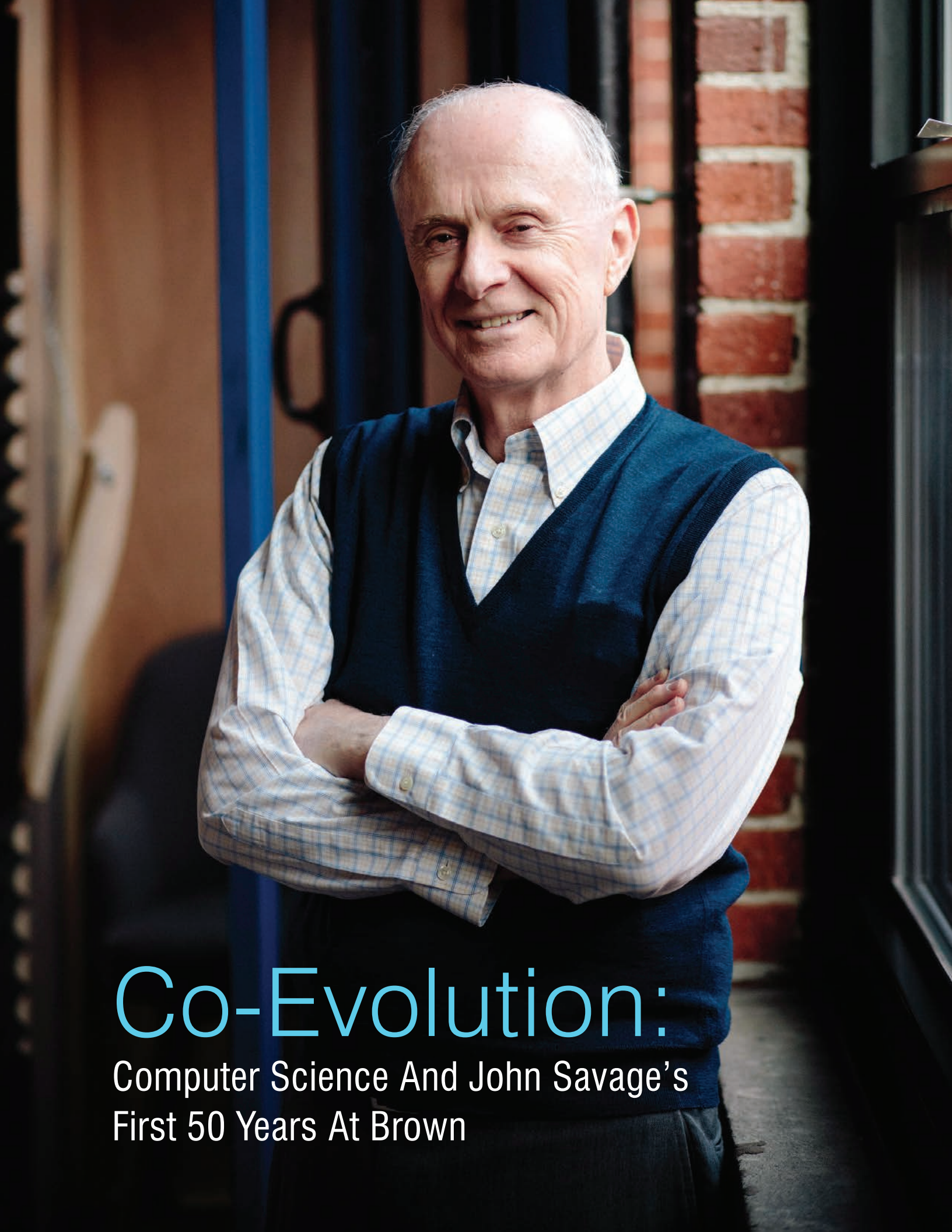
This understanding is represented in James's interest in interaction, a thread that runs through almost a decade of research. "I create graphics, vision, and interaction techniques to improve our understanding of the connections within media," he explains, "to further our ability to edit and explore the visual world." The interest in interaction may have early origins: as a child, growing up in the London suburbs, he favored Fighting Fantasy non-linear gamebooks, tabletop and computer strategy games like X-COM, and "played tremendously with LEGO". His father, the headmaster of a local high school, would bring home a succession of clunky, barely-portable computers, "...and then I would break them," James grins, "as part of the 'learning process.'"

Combined interests in computation and music spiralled outward from those early days of tinkering, leading to an undergraduate thesis at King's College London in novel interaction methods for composing music. Later, at University College London, Tompkin's work with visual computing and his association with architects at the interdisciplinary Bartlett Centre for Advanced Spatial Analysis only heightened his interest in not just the interactive but the tangible. "I like interfaces that exist in the real world," he says, "and if you want more natural interfaces, you have to build them. A lot of my work is pixel-pushing, but sometimes you want to go into a machine shop and build something."

After work at the Intel Visual Computing Institute, the Max-Planck-Institute for Informatics, and recent postdoctoral research at the Harvard Paulson School of Engineering and Applied Sciences, James found himself drawn to the "exceptional" students of Brown and the faculty's rapport with them. "I think Brown is different. There's a focus on teaching and really a will to support students. The ratio of TAs to undergraduate students is impressive, and I've worked with a Brown CS PhD, so I have a healthy respect for them too." James is also enthusiastic about the proximity to the Rhode Island School of Design. "I have so much appreciation for the work of designers," Tompkin says. "Computer scientists, we're so in the box! It helps to look outside."

So, what is he excited about doing here at Brown? James pauses for a second. "Computer graphics is in a very interesting position at the moment. In many ways, we've already solved the grand challenge of realistic image synthesis. Think about that: how many fields can say, 'We did it all in about fifty years. Sorry!' That amazes me." But the amazement quickly gives way to a maker's eagerness: "In visual computing, I see a mismatch between how we see and interact with the world and the tools that we use to capture it. Video is most similar to how we actually see. It's a powerful medium: extremely fun, highly creative, good for storytelling, but it's still very difficult to use. My research tries to remove some of these barriers to self-expression. I'm so pleased that as a community, we're developing cheap and good ways for people to use cameras to make rich models of the world around them. This lets us give powerful new tools to novices and professionals, and expand what is possible with media, especially interactive media."

As the credits roll on his research video and an orchestral score wafts in, Tompkin casually tosses out one more marvel: an antique view camera with a tablet housed inside, letting the viewer explore the Hitchcock classic *Rear Window* in real time as the voyeur, panning and zooming and changing perspective. "Most of the things people want to do are related to the real world," James notes, "firmly grounded in reality. That's why I try to make camera-captured media easier to create, analyse, and explore." But like everything else on his resume, this looks highly creative. And extremely fun.



Co-Evolution:

Computer Science And John Savage's First 50 Years At Brown

When John Savage came to Brown a half-century ago, computing was thought of as a service, not a discipline, and the idea of a Department of Computer Science at Brown was highly controversial. Few could have predicted the infrastructure necessary today, or the challenges we face in the areas of cryptography, cybereconomics, big data, and many others.

One of the founders of Brown CS, John's interests have changed as our field has changed, leading him to contribute to such areas as computational complexity, scientific computation, computational nanotechnology, and cybersecurity policy and technology. In place of our annual reunion, we hope you're planning to join us in Room 130 of 85 Waterman Street from 2-6 PM on Friday, May 26, for a celebration of how John Savage and Brown CS evolved together, including research talks as well as personal reminiscences. A reception will follow at 115 Waterman Street on the third floor of the CIT.

In preparation for all the fun, let's take a moment to go back in time and take a look at 50 years of co-evolution.

STARTING OUT

"I've had an interesting career," says John Savage. He's sitting in his office on the fifth floor of the CIT, looking out onto rooftops in January sunlight. "I don't enjoy talking about myself, but I like discussing my work. I hope it provides motivation for others to reach out, to experiment."

The impetus of that career, which has ranged as widely as any in the field, began in Lynn, Massachusetts, where John was the oldest of six children, growing up in a French-Canadian neighborhood and attending schools where some of the instruction was in French. (He still speaks the language.) "Somehow," he says mysteriously, he acquired a BB gun in his preteen years. "But I was told it was dangerous and urged to get rid of it."

John set aside his hopes of becoming a sharpshooter, abandoning the gun in favor of a crystal radio. "I was absolutely fascinated by it," he says. In his teens, studying at the now-defunct Saint Jean Baptiste High School, a French-Canadian parochial school, he became a ham radio operator, upgrading to a 400 MHz receiver/transmitter and working on his Morse code skills until he could transmit 17 words per minute. Like many other enthusiasts, he enjoyed communicating with peers around the world. "But unlike them," John says, "I was more interested in the technology."

Inspired to pursue electrical engineering in college, John knew that he needed physics, so he took a night class at the public high school. He soon discovered that the physics teacher, an out-of-his-element basketball coach, was confused by course material about levers that he was supposed to be explaining to students. He sent out his college applications, and the acceptances started coming in: Tufts, then Northeastern. But at MIT, his first choice, John was waitlisted. This meant a visit to the Dean of Admissions, the intimidatingly-named B. Alden Thresher. "He sat at this massive desk in the middle of a big room," John remembers. "His secretary pulled my folder, and then he looked at my letters of recommendation. 'Nothing special!' he said."

Antone ("Tony") Medeiros, Professor Emeritus of Medicine at Brown, met John in 1976, and they biked around the East Side every morning together for years. He adds an interesting detail to the story: "When the dean told John that ham radio enthusiasts didn't often do well at MIT, John had an answer, which was that he was less interested in radio techniques and more interested in the ideas behind the technology. That says something."

MIT YEARS

Whatever the reason, Thresher relented. It was an early success with something that John was to do again and again in his future career, making a case for something against difficult odds and delivering a convincing argument. MIT was a financial challenge as much as an intellectual one: John commuted from home, paying tuition first with a $400 scholarship from his church and earnings from a paper

route, then working in the refectory, then with a $100 loan from his father, a self-made man whose parents had died young. Eventually, a Massachusetts Bay Scholarship eliminated the need for John to work, which was fortunate. "Going in," he says, "I'd only had a half-course of trigonometry, and some of my classmates had taken calculus. At the end of the first semester, my grades were exactly the mean for my class!"

As an undergraduate John joined the Cooperative Program at MIT and spent semesters with 25,000 engineers at Bell Labs, working at locations in New Jersey and Massachusetts. Before each assignment he requested that he be allowed to work with antennas, a subject that fascinated him. He was taken to Holmdel and told that they needed to calibrate a massive antenna by pointing it at radio stars, a job known as "bore sighting". Deciding that this was not the kind of antenna work he envisioned doing, he took an assignment in signal processing. However, the people who did work with the Holmdel Horn Antenna noticed an inexplicable hissing sound. When it was investigated it provided evidence for the Big Bang and led to the Nobel Prize in Physics for Arno Penzias and Robert Woodrow Wilson for the discovery of cosmic microwave background radiation. John had narrowly missed a big opportunity.

John earned his ScB from MIT in 1961, then stayed on to earn his ScM a year later and a PhD in 1965. A return to Bell Labs followed, where one of the projects he worked on was a digital data scrambler that scrambled a bitstream so that it would be unintelligible without the appropriate descrambler. He also met his wife, the descendant of multiple Brown alums, in Cambridge (John had borrowed a friend's ID to obtain access to a Harvard event). Her father played a key role in John's choice of both career and home.

"I thought I'd get an industry job, but my father-in-law recommended Brown. Providence was very different then: there wasn't any Interstate 95, and we wondered where we'd live. I thought we'd be here about three years," John laughs.

A COMBINED APPROACH

John's industry experience proved to be extremely useful for future academic work. His PhD thesis had been on sequential decoding, and at Bell Labs, he noticed the huge disparity between the size of encoders and decoders. It was the beginning of a long-term interest in how the idea of complexity was relevant to computing in general, which John pursued across multiple research projects, including a 1972 paper ("Computational Work and Time on Finite Machines") for the *Journal of the Association for Computing Machinery.*

Barrett Hazeltine, Professor of Engineering Emeritus and Adjunct Professor of Engineering, has known John from his earliest days at Brown. "It's hard to explain this now that everyone understands the value of computer science," he notes, "but we deal with gigabits now, and John was a real pioneer of complexity and minimization in the days when you had to build every gate by hand. There really wasn't anyone else doing CS with his combined approach of engineering, math, and theory."

In the years to follow, Savage's interests grew to encompass applied theory of computation, which includes space-time tradeoffs in serial computation and area-time tradeoffs in the very large scale integrated (VLSI) model of computation, as well as silicon compilers (John notes that colleague Steve Reiss wrote code for one of the earliest of these) and the parallel algorithms used with them.

"Computational complexity is still interesting to me," John says. "One of my early computer science results was reminiscent of the Heisenberg Uncertainty Principle. I demonstrated that the product of storage space and computation time on a random access machine could not both be made arbitrarily small simultaneously. The circuit complexity of the problem being computed puts a lower limit on the product."

A NEW FRAMEWORK

John's imagined three years at Brown became six, and when his first sabbatical arrived, he brought his wife and two small children to the Netherlands. While there, an important long-distance conversation with colleagues Andy van Dam and Peter Wegner was starting. A movement had slowly begun: universities nationwide were establishing Departments of Computer Science, primarily for graduate studies.

At the time, some faculty members of Brown's Divisions of Applied Math and Engineering considered themselves computer scientists and were teaching what were effectively CS courses. Capitalizing on those early efforts, Savage, van Dam, and Wegner wanted to create a new framework for the study of CS at Brown. An initial attempt to obtain permission for a Department

Top to bottom, clockwise //

John meeting Secretary of State Clinton with other Jefferson Science Fellows

John in Kassar House, discussing the model for expansion of the department's first building in 1982

John in the chair's office in the CIT, 1988

Jeff Vitter, Paris Kanellakis, Roberto Tamassia, John, and Philip Klein: the Brown CS Theory Group, 1990

Newlyweds John and Patricia, 1966

of Computer Science failed, but with the aid of Maurice Glicksman (first Dean of the Graduate School and later Provost), the three created a cross-Division Program in Computer Science in 1975.

"After we proved through being a Program that we were a survivable entity," Andy remembers, "we asked again about becoming a Department, and that's when the antibodies came flooding out. There was fear and even anger that we were proposing to remove valued parts of both Applied Math and Engineering, and Maurice had to make assurances that new positions would be made available to the Divisions. Throughout the whole effort, John and I had complementary views that CS was worthy of becoming a unit of some kind, and we each represented part of the entire discipline. He and I worked together to advance the ball, so I know how much effort he put into it. He was definitely skilled at building the argumentation and delivering it effectively."

Four years after the Program was established, John assembled a committee that included such luminaries as Dick Karp (University of California, Berkeley), Peter Elias (MIT), Juris Hartmanis (Cornell), and Alan Newell (Carnegie Mellon), and the trio's years of effort finally paid off with the creation of the Department of Computer Science in 1979. "John saw beyond that era's conceptions of what computer science was," says Tony Medeiros. "And then he ran with it!" But even the inaugural symposium, which John organized, wasn't without its challenges: a student, perhaps overawed by the honor of carrying slides for the world-renowned Donald Knuth, who gave the keynote address, promptly spilled the entire carousel on the floor.

"Our department has worked together so well for decades," John says, "and to some degree, I take it as a measure of success of our launch. We established practices that are still followed today, and we balanced theory and practice at a time when our competitors were only doing one or the other. One of the first things that our new faculty members say is that our faculty gets along. By no means is that true everywhere!"

IN THE CHAIR

The 1980s were a time of rapid growth for Brown CS. Early in the decade, grants from the National Science Foundation and Exxon funded the first electronic workstation classroom and the first large group of networked Apollo workstations anywhere. John followed Andy as Department Chair, and by his second year in the role, new workstations were needed. John led the effort of creating a request for proposal to all vendors, which were eventually narrowed down to Sun, DEC, and NeXT. The goal was what was called a "3M" machine: one million bytes of memory, cycles per second, and pixels on a screen. A highly contentious "bake-off" (Steve Jobs of NeXT was in his argumentative prime) followed, with Tom Doeppner making the case for Sun, Steve Reiss for DEC, and Andy van Dam for NeXT. Sun was the winner, resulting in a multi-decade relationship.

"There was always a lot of back and forth when I was Chair," John remembers. "Between students and faculty, among faculty members, with the administration. I started weekly faculty meetings over lunch to help us solve problems collaboratively, and they continue today."

"Our department has worked together so well for decades and to some degree, I take it as a measure of success of our launch."

Andy notes, "As Chair, John maintained his strong interest in growing the department. He stayed the course, which for that particular time period was much more challenging than it sounds, given that we were still a very small department trying to compete for faculty, students, and research grants with much better-known and much larger CS departments. Absolutely, he was a great Chair, always active, always helping to build in a variety of ways."

Another of John's major contributions was the Industry Partners Program (IPP), which he founded in 1989 in conjunction with Brown's Development Office and Roy Bonner of IBM. The program creates closer connections between Brown CS and industry, and member companies are encouraged to recruit students, participate in the selection of topics for IPP symposia, and advise on the employment and research needs of corporations. Income from the program has proved crucial to the department's growth, supporting

everything from equipment to faculty searches to distinguished lectures.

The most visible reminder of John's days as Department Chair is the Thomas J. Watson, Senior Center for Information Technology (the CIT). Andy explains that the building was finished on John's watch, and he oversaw its execution: "You could count on John. If he said he'd do something, he got it done, on time, and with high quality." Professor Stan Zdonik adds that John's work as Department Chair was one of his biggest contributions to Brown CS. "He took the job extremely seriously and did great things," says Stan. "He was part of a small group of people who deserve huge credit for basically getting the CIT built. That took an incredible amount of work with the university, getting people to agree."

AN AWFUL LOT TO LEARN

In the 1980s and into the early 1990s, John's research focused on algorithms to support silicon computation. In the mid-1990s, John began doing research with his PhD candidate, Jose Castellanos, on a problem in scientific computing. Their research on the implementation of the finite element method in a distributed computing environment earned Jose a position on the IBM Blue Gene team.

It was more evidence for the polymathy that's been a hallmark of his career. "When I met John in 1976," says Tony Medeiros, "personal computing was in its early days, and I was a bit of a techie, which meant stepping outside my field, but I was nothing compared to John, who was full of wonderful ideas in my area of interest, microbial antibiotic resistance, and everything else. You couldn't bring up a topic that he wasn't intrigued about."

"Ideas excite me," John says when asked to explain his wide-ranging interests, telling the story of how he took charge of his college education after being poorly prepared in high school, and was motivated to delve into computational nanotechnology by reading through a rising stack of nanotechnology papers on his desk, plunging in even when he didn't fully understand them. "I can't really help being curious about things, and I have other interests that I haven't fully explored, like cryptography. There's still an awful lot to learn."

John's work with nanotechnology began in 2001, with a one-year starter grant. That led to a large four-year NSF grant that he shared with Charles Lieber of Harvard and André DeHon of Caltech. He says, "When I discovered nanotechnology, I thought it would have the impact that the VLSI revolution did in the 1970s. It hasn't turned out that way yet, but it might eventually." Meanwhile, he was learning by attacking the problem in several different directions: giving lots of talks and developing an introductory course on nanotechnology that included quantum computing, nanowire-based technology, and synthetic computing. His research continued until 2011, and he earned his last patent in the area in 2016. Most recently, John's interest in applied theory of computation has led to publications on input/output complexity for multi-core chips with shared memory.

According to Barrett Hazeltine, the pleasure that John gets out of new and varied research finds synergy with his interpersonal skill: "When you talk to John, you see that he's enjoying what he's doing, and he expects people to do the same. 'Wouldn't it be fun if' is how he starts a conversation. Maybe because of his many interests, he gets people to approach their research in another way, and he's gracious, he makes you think you're the most important person in the room. He's a very strong colleague who's had the courage to change the university for the better in many ways."

SERVICE NEAR AND FAR

Much of this change has occurred through John's decades of service to Brown, often during times of protest (in response to the effect that the proposed 1975-1976 budget would have on minorities, students occupied University Hall) and strained relations between the faculty and administration. Savage has been Chair, Vice Chair, and Past Chair of the Faculty, Chair of the Task Force on Faculty Governance, Chair of the Nominations Committee, Chair of the Search Committee for Vice President for Public Affairs and University Relations, President of the Faculty Club Board of Managers, and a chair or member of numerous other committees. Among many other achievements, he formed the Academic Priorities Committee, made significant changes to policies concerning budgets and tenure, and created a massive Handbook for the Task Force on Faculty Governance. In recognition of all these efforts, John received the President's Award for Excellence in Faculty Governance in 2009.

"A lot of people see service as a chore," Barrett adds, "but John is both a leader and a doer. He answered the

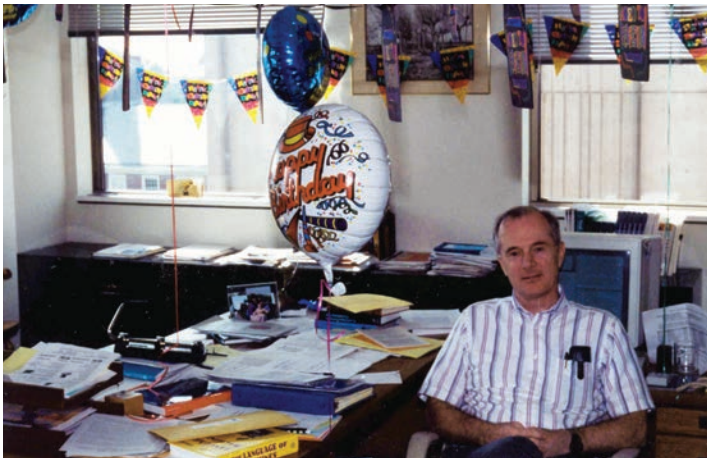
question of how faculty can usefully contribute to how Brown runs. He's one of the people responsible for all the benefit we get from being in a community where the best ideas can come forth and be made known."

And although it might not be service in the traditional sense, Tony Medeiros points out the Savage family's incredible allegiance to Brown: "I don't know if anyone else has said it, so I want to mention that John may have set some kind of a record: all four of his children went to Brown and married Brown alums. He's a great father and family man, a wonderful friend."

John's service has also taken him far beyond the Van Wickle Gates. His contributions to professional societies have been many, including being chosen as a member of the NSF Review Panel on Emerging Technologies and the Program Committee for the IEEE/ACM International Symposium On Nanoscale Architectures. But it's John's work in cybersecurity and Internet governance that's had a truly international scale: he's served as a Jefferson Science Fellow for the US Department of State, a panelist for the Global Futures Forum in Singapore, an honored guest of the government of Vietnam, and a member of the Scientific and Technical Intelligence Committee.

Judith Strotz, Director of the Office of Cyber Affairs at the US Department of State, worked extensively with John when he was asked to help policymakers in her newly-formed Office better understand science and follow rapidly-emerging trends. "To me," she says, "the main thing is that he trained us all. It doesn't sound momentous, but it really is. It's really hard for non-scientists to address all these issues, and we made huge strides thanks to his knowledge, persistence, and patience. He's a true expert and a great colleague who helped us sort through problems and find a way forward. I miss working with him."

John is also a Professorial Fellow for the EastWest Institute, a non-profit organization with the goal of reducing conflict worldwide. Bruce McConnell is the organization's Global Vice-President, and one of Savage's frequent collaborators, including a recent paper on Internet governance. He says, "John's influence and impact are immeasurable…He's hardworking, and when he says he'll do something, he gets it done. But then he goes beyond that by bringing his enthusiasm, curiosity, and creativity. He always opens up options."



Above // John celebrates his birthday in the CIT, 2004.

"It's been great fun," John says of his time in Washington, remembering days when he had the maximum level of security clearance, unable to bring any technology into his office and required to store his top-secret disk in a safe every night. Always the educator, he makes an interesting point about autodidacticism: "90 to 95 percent of the information used in intelligence analysis is open source. A deep understanding of a region or country is something that can be taught, and avid readers who devote themselves to an area can teach themselves."

GREAT TEACHING

When asked about John's contributions, Judith Strotz begins with his instructional skill, saying, "John is really humble. He taught our team of policy makers in simple terms at first, but without ever being condescending. He showed respect and understanding of where everyone was at in order to help them learn. To me, that's great teaching."

Over the years, John has taught more than 15 courses at Brown, covering topics from computational complexity to cybersecurity. This spring, he's teaching CSCI 1800 Cybersecurity and International Relations for the seventh time, bringing the subject material to life with a series of world-class speakers, including an expert in cyber economics and the National Intelligence Officer for Cyber Issues.

He's also fielded multiple winning teams of students at the CYFY, CyberSeed, and Cyber 9/12 competitions. "Teaching is how I get firsthand experience," he says, citing a class (CSCI 1951-E Computer Systems

Security: Principles and Practice) that functions as an enriched version of a course developed by Professor Roberto Tamassia. "The best way to fill gaps in my knowledge is to study something, then teach it."

CO-EVOLUTION

The theme of co-evolution was John's carefully-considered choice for the upcoming celebration in May. It reflects not just his multifaceted career and the growth of our department but the evolving face of computer science and the continuing challenge of developing the technology needed for a changing world.

"Start by thinking about how difficult it is to build an operating system," John says. "Very roughly, you're looking at 80 million lines of code that have to be designed, written, tested, documented. If someone can write 20 lines of code per day, at 250 working days per year, you're looking at 16,000 person-years of work. It's an enormous effort."

At the same time as John and his colleagues were crafting policy and procedure for an evolving Brown CS, they were creating an equivalent framework for computer science itself: "Over the years, we've had to build the entire infrastructure to support our own discipline: we had to invent computer graphics so we could have graphical user interfaces, we had to create operating systems that scheduled jobs correctly, we had to define protocols for sending packets so the Internet can work. If this had been commonly understood in the 1970s, we would've been given a department the first time we asked!"

And yet there's no sign of cynicism in the remark. Bruce McConnell sees John's positivity as an unmistakable part of his secret to success: "He always sees another angle and brings in ideas from other domains. It's intellect plus optimism. For John, the glass is always more than half full!"

The next set of challenges, John explains, demands rigor. As scientists, responsibility has been placed directly in front of us. "Most people can learn to write software for simple tasks," he says, "but the difficult problems need scientists. There are new challenges in artificial intelligence, cybersecurity, nanotechnology, data science. There are very specific problems, like the role of social media in promoting fake news or the ethical questions of self-driving cars, which demonstrate that we're in an era where the technology we invented has unintended consequences. Computer science has become a critically important field. These are technical challenges that demand expertise and will play out on a social, economic, and geopolitical scale. We need to play a central role."

That role is also an interdisciplinary and intersectional one: "Computer science will become important to more and more people. I'd love to see more women in the field and more historically underrepresented groups: we need different perspectives because of the impact that we're having on international relations, engineering, and other areas. I want to see people be tolerant and generous with each other -- we're all human beings. A hundred thousand years of thought have gone into our survival, and we need to cooperate and pass on knowledge. My message to the next generation of students is to stay positive: when you encounter problems, get the best advice, work them out, keep plowing through, and don't give up."

"Whatever the challenge is, John always has ideas. It's trivial to say that John is incredibly smart, but his enthusiasm has always taken him everywhere, and it still does."

John Savage's track record shows a more than ample willingness to take up that gauntlet with energy and purpose. "He has this quality," says Andy van Dam, "of positivity and non-superficiality, of digging in, of having a grounded position and willingness to keep pushing at something."

"Whatever the challenge is," says Tony Medeiros, "he always has ideas. It's trivial to say that John is incredibly smart, but his enthusiasm has always taken him everywhere, and it still does."

Following Up With The Winners Of The

2016 Senior Prize In Computer Science

by Monica Zuraw

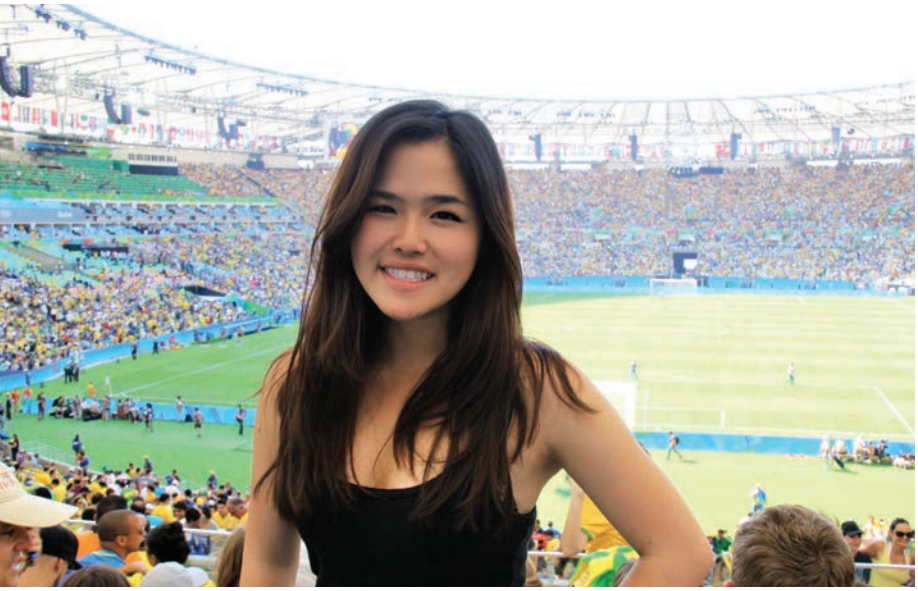
Last year, Brown CS recognized five graduating seniors for their achievements at Commencement in May of 2016. Samuel Ainsworth, Allison Hamburger, Sharon Lo, Eli Rosenthal, and Sarah Sachs received the Senior Prize in Computer Science for their academic work as well as their service to the Department.

This group of students impressed the department with their superior academic efforts, independent research, and thesis work. In addition, they went above and beyond to aid the department through TAing and involvement with various groups, including WiCS and Diversity and Inclusion. Since graduating, these students have continued to do amazing work in the field of computer science, and we managed to get in touch with four of them to learn more.

Samuel Ainsworth will be starting a PhD program in Computer Science, Statistics, and Machine Learning at the University of Washington this fall. Since graduating, he has been developing a large range of skills and experience through several internships. Recently, Sam finished up a position as a research intern for a Bayesian optimization company called SigOpt. "SigOpt helps companies accelerate new product development and reduce trial and error," says Sam. "For example, if a brewery comes to us, we'll help them optimize their brewing process by giving them different parameters to try. They test out those parameters and tell us how much the process has improved. Then we figure out how to do that with multiple objectives in mind, such as good taste and quality."

Allison Hamburger has joined Adobe as a software engineer, working on Photoshop. "It's really exciting to be working on a product that's been around for so long because it means that the people I work with have an incredible base of knowledge," says Allison. "Some of them have been working on Photoshop for 20 years! As a newer engineer, it's been really valuable to be able to keep learning from my coworkers even though I'm not in school anymore. Even when working on a tiny slice of an application, there are so many aspects of the technology to understand and a lot of perspective on engineering to gain." Allison is particularly interested in computer graphics, and enjoys working at a company where graphics are at the forefront.

Sharon Lo is currently working as a program manager at Microsoft on their cloud platform, Azure. "It was definitely a transition," says Sharon, "but I've learned how to start leveraging my Brown education into the projects I'm working on and take holistic approaches in what I do." She has found that her past experiences in



> "I've learned how to start leveraging my Brown education into the projects I'm working on and take holistic approaches in what I do."

Hack@Brown and as a TA for Brown CS have helped her in the work environment. Sharon is also getting involved in mentoring and teaching local high school students, specifically minorities and women, about coding.

Sarah Sachs is a software engineer at Google, working on location-based and geographically-based search experiences. "Being a TA and a student at Brown have prepared me with how and when to ask questions, which I've found to be extremely valuable at work," says Sarah. She's currently focusing on dining and restaurant searches where she uses math, science, rankings, and user-focused reviews to produce optimal results. "I love what I'm doing! I rely heavily on Google and information sites when I go out to eat because I am celiac, so it's great to be working on a product that's practical and useful." Outside of her work, Sarah continues to express her passion for CS. She will be a corporate mentor with Google for Hack@Brown this year and was recently published in the Washington Post for an article she wrote on the challenges of feeling like an impostor as a woman in software, and how she overcame this fear.

Brown CS is extremely proud to see the various ways our graduates have continued to excel. The Senior Prize in Computer Science will be given out again this year during Commencement in May to a group of students that have demonstrated similar drive, dedication, and service as last year's deserving winners.

Top Left // Samuel Ainsworth
Top Right // Sarah Sachs
Bottom // Sharon Lo

Brown CS Alum
Sridhar Ramaswamy,
SVP Of Advertising And Commerce At Google, Receives The Horace Mann Medal

Brown CS is proud to announce a historic moment: alum Sridhar Ramaswamy's achievements in the field have earned the first Horace Mann Medal for a computer scientist. Dean Peter M. Weber presented the award, given annually to a Brown University Graduate School alum who has made significant contributions to their field, at the Graduate School Doctoral Ceremony on May 29, 2016.

Part of a group of senior executives who report directly to CEO Sundar Pichai, Ramaswamy is currently the Senior Vice President of Advertising and Commerce at Google, where he oversees the design, innovation, and engineering of the company's advertising and commerce products. As leader of the engineering teams that helped define the vision and direction of AdWords, which built Google's multi-billion-dollar advertising business, he now directs the company's efforts in search advertising, display and video advertising, Google Shopping, Android Pay, and many other global platforms.

Prior to joining Google, Sridhar worked for Bellcore and Bell Labs, helping create a revolutionary system called AQUA (Approximate QUery Answering) that was aimed at providing provable guarantees for fast answers on massive datasets. His research provided the first efficient algorithm for mining outliers in large datasets and is considered a pioneering contribution to the field. Since then, his numerous innovations include the creation of online auction models with highly precise ad delivery, the development of a scientific framework and platform for understanding how website layouts and user interface components impact online monetization, and the establishment of ads quality systems.

Sridhar received his PhD in Computer Science in 1995 but continues to contribute to Brown CS, serving in the inaugural cohort of the Department's Advisory Board and delivering the first lecture in the IT Leaders Lecture Series. Interviewed prior to the event, he spoke of his love for solving the unsolvable: "What excites me is that computing itself is very young. It's only begun to touch numerous aspects of our life. I can point kids to so many different areas and tell them that there are thousands of possible futures there, just waiting!"

"This is tremendous news," says Brown CS Department Chair Ugur Cetintemel. "We're proud of Sridhar's remarkable accomplishments and their daily impact on so many people worldwide. He's unique: our students who hope to lead and innovate in both technology and business couldn't ask for a better role model."

PETER WEGNER

A Life Remarkable

Students who have recently arrived at the CIT may only know Peter Wegner, now retired for more than a decade, through his vigorous participation in colloquia. Others will be familiar with his research in programming languages. But as he nears a half-century at Brown, not just the course of his career but the story of his life bears telling, and in this second installment, Peter continues to tell his story in his own words.

Shortly after his mother's death, Peter asked the local education authorities for financial support, and they agreed to underwrite his college tuition. He was very grateful both to Marks and Spencer for supporting his move to Britain, and for the Labour Government's financial support of his University education despite the fact that he was not a British citizen!

During his final year at the Regent Street Poly, Peter took an exam to enter Imperial College of London University, where he was accepted as a mathematics student in 1950 to work towards an undergraduate degree. His department head, Professor Hyman Levy, was a well-known Communist who, however, was expelled from the British Communist Party for writing an article that criticized the Soviet régime's treatment of Jews.

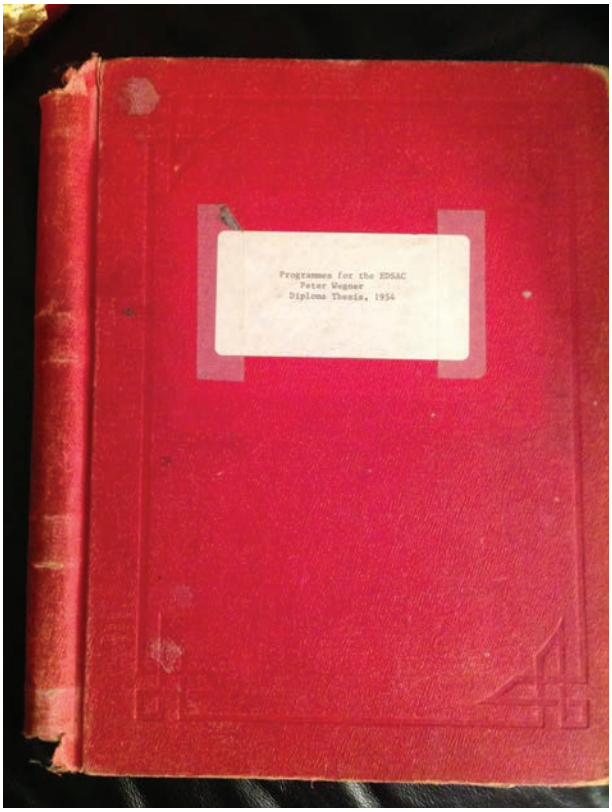
While studying mathematics at Imperial College, Peter took Prof. A.J. Ayer's philosophy course at University College, on his book *Language, Truth and Logic,* during which Peter gave a talk about the impact of philosophy on logic and computing. He also organized the University of London Philosophical Study Group, which sponsored lectures by well-known philosophers like C.E.M. Joad, J.B.S. Haldane and Karl Popper. These evening lectures were preceded by dinners at which Peter had discussions with the speakers. His interest in philosophy has continued throughout his life, and his writings about computers often include philosophical analysis.

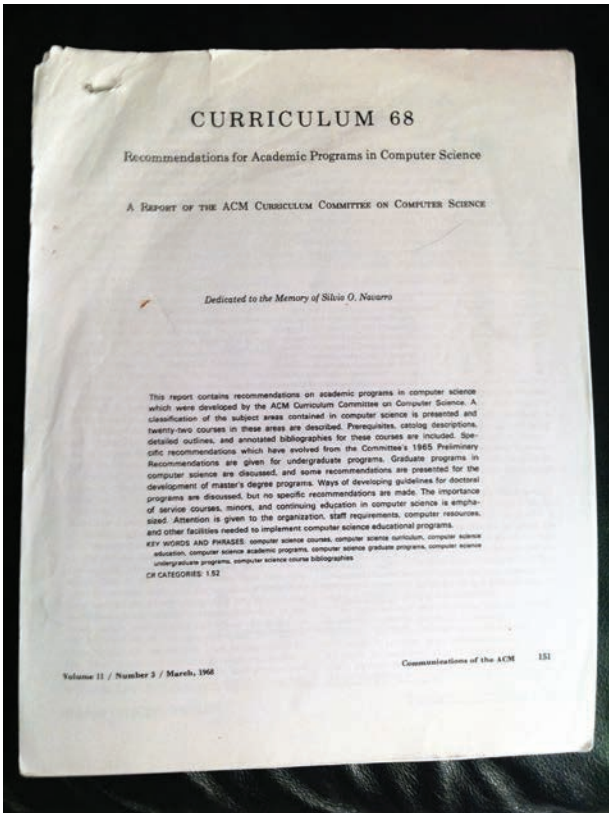
During his final year at Imperial College (1952-3), Peter attended a lecture on computing by Prof. Douglas Hartree of Cambridge University, who invited him to work on the EDSAC computer in Cambridge during the summer, after completing his undergraduate degree. Peter was lucky to be invited to work on the EDSAC; this invitation was because he had personally met and interacted with Prof. Hartree following his talk.

After completing his summer job, Peter registered for a graduate program at Cambridge in Numerical Analysis and Automatic Computing, which included courses on both the structure of computing and mathematical programming techniques. He interacted strongly with Prof. Maurice Wilkes, Department Head and designer of the EDSAC, who asked Peter to write historical articles on early pioneers like Leibniz and Babbage. Peter stayed in touch with Wilkes throughout the latter's life, later inviting him to lecture at Brown, and visited him at Cambridge in the year before his death. Wilkes received a Turing Award in the 1980s and was knighted by the Queen during the 1990s, after which Peter began to address him as "Sir Maurice."

In June 1954, Peter took his Final exams. By coincidence, these were held during the week when Alan Turing (who created Turing machines and had cracked the German Enigma code during World War Two) committed suicide because the police were prosecuting him for homosexual activities (then still illegal in England, the United States and elsewhere). Maurice Wilkes informed Peter of Turing's death while he was actually taking his exam. Today, of course, Turing is venerated as a founder of computer science, and the Turing Award is seen as the equivalent of a Nobel prize for computer research. Wilkes and Turing knew each other well, and Wilkes felt that although Turing was a brilliant theoretician, he had not managed to build an actual computer because he was unable to organize the people needed to build them.

During his year at Cambridge, Peter often ate dinner on Friday night at the Cambridge University Jewish Society, where he interacted with other Jewish students. It was there that he met Judith Romney, a Newnham College student, who was nicknamed "Second-verse Romney" because she knew by heart all the words of all the verses of the Hebrew liturgical songs that the students sang during the Sabbath meals. Though they hardly interacted while at Cambridge, Peter and Judith





Upper Left // Peter's 1954 diploma thesis

Upper Right // An oil painting of Peter and Judith's wedding

Lower Left // A copy of "Curriculum 68"

met again by serendipity two years later on a tightly packed London Tube train; and the close proximity fostered by rush-hour travel led to their engagement and their marriage.

In 1954, Peter had received, along with two fellow-students, the "Post-Graduate Diploma in Numerical Analysis and Automatic Computing" (this was before there were any Master's or Doctoral programs in Computer Science anywhere in the world), then worked briefly at the Manchester University Computer Science department. He then visited Israel for an academic year, where he was invited to the Weizmann Institute to work on the WEIZAC computer. His boss, Chaim Pekeris, asked him to explore mathematically the chances of finding underground oil in Israel (alas, none was ever found!) Peter returned to England the following year (1955); and he has since visited Israel several times, to lecture at the Hebrew University, the Haifa Technion, and other institutions.

On his return to England, Peter was hired by the Prudential Insurance Company developing actuarial software, and at that time he planned to qualify as an actuary. It was during this period that, as mentioned above, he ran into Judith during the rush hour. She lived in Wembley and, like Peter, was taking a Tube train into town every day to attend a Bar Final preparation course at Gibson and Weldon. (England had, and still has, no actual law schools of the kind prevalent in the United States.) Judith and Peter dated a few times, became engaged, and were married a year later in July of 1956.

Peter changed jobs in early 1956, joining CAV, an aerospace company, where he worked on airline programming with several former college mates from Imperial College. But soon after his marriage, he was offered a job at Penn State University under the Exchange Visitors program, popularly known as the "brain drain." Even though the decision to leave England interfered with Judith's legal aspirations, the Wegners decided to accept the offer, since the salary was far higher and Peter was more than happy to become an academic. In addition to the higher salary, the University supported research with grants. In 1959, after spending two years at Penn State, Peter was offered a job at MIT, where he worked with Fernando Corbato on the Multics project, for which Corbato would later receive a Turing Award.

At about the same time, Peter and Judith's first child was born, and Peter made a brief trip to England to be present at the birth, but had to return quickly to continue his work at MIT. Judith brought their baby son to the USA after Peter had found a suitable apartment in Brookline. In 1960, Peter moved from MIT to Harvard, where he worked in the Mathematical Laboratory, helping faculty in economics and other disciplines with their programing requirements.

Then, in 1961, Peter was offered a lectureship at the London School of Economics, to lecture to economists on computing. Peter and Judith had always planned on returning to England, and were happy to take this opportunity. They bought a house in the London suburb of Harrow, and Peter traveled by train every day for an hour to his job in Central London.

The job at LSE was very rewarding, as several of the professors worked for the Government and had offices both at LSE and in Whitehall. They had interesting things to say about their government activities. Peter organized several computer conferences at LSE, and managed to write two books about computing while at LSE. To learn more about computing he attended several computer science conferences where lecturers described new practical and theoretical research. Peter's reviews of these conferences, published in a computer journal, received high praise from the organizers.

But the low salary made it difficult to manage in London, and after three years at LSE the couple decided to return to America. Peter was offered an assistant professorship in the mathematics department at Penn State in 1964 -- this time with a green card that permitted the Wegners to reside permanently in the United States. On their return to Penn State, Peter taught courses on computing and invited well-known lecturers to speak about their latest research. His invitation of Juris Hartmanis to lecture on his work on computational complexity (for which he had received a Turing Award) led to an invitation to Cornell when Hartmanis was asked to found the Cornell computer science department in 1966, and Peter moved to Cornell to become one of the initial members of that department.

Cornell computer science faculty frequently had lunch together and discussed both their personal lives and their research over lunch. Peter learned a lot about Hartmanis's early life in Latvia, and about his father, a Latvian general, who, like Peter's own father, had been executed by the Russians. While at Cornell, Peter taught a revised course on programming languages and completed his book, *Programming Languages, Information Structures, and Machine Organization* (1969), which examined the evolution of programming languages and their relation to the broader discipline of computer science. He established a relationship with Donald Knuth, who was writing the first of his books on computer science and invited Peter to his house in Pasadena to show him early drafts of several computer texts he was planning to write. Peter invited Knuth to lecture at Cornell, and one weekend, they decided to attend services both at the local synagogue and at a Lutheran church. They discussed the possibility of writing a joint book, but did not do because their research techniques were very different.

While Peter was working on his book he also became a member of the ACM Curriculum Committee, which was creating a curriculum for teaching computer science. He was a central contributor to "Curriculum 68," published by the *Communications of the ACM* in 1968, which included a detailed analysis of the ACM curriculum that was widely adopted by many universities during the next ten years. Peter is a good writer, and believes that the quality of his writing may have made a bigger contribution to his status than actual research, though both were non-negligible.

In 1969, Brown University offered Peter a position with tenure, and he accepted the offer.

Department Awards and Honors

Each item below is just the headline of an entire story for you to read, complete with photos and links and additional resources. **For full versions, please visit www.cs.brown.edu, where they're featured at either CS News or CS Blog:**

Krishna Chaitanya Aluru Wins A Y Combinator Fellowship

David Abel Has Been Selected For Brown's Highly Competitive Open Graduate Education Program

Bootstrap Plays A Key Role In CS4RI Expansion Of CS Education In Rhode Island

The White House Cites **Bootstrap**'s Contributions To Maryland's Successful "CS For All" Efforts

Brown CS Has Been Rated The Fifth Most Advanced CS Department In America

An Interdisciplinary Team Including Multiple **Brown CS Students** Wins An Award At MIT Grand Hack 2016

Brown CS Students Make Another Strong Showing At The Third Annual Cyber 9/12 Student Competition

Brown CS TAs Of CS 15 Win Second Place At HealthHacks RI Hackathon

Brown CS Alum **Hoon Ik Chang** Has Been Named A 2017 Schwarzman Scholar

Brown CS Student **Tiffany Chen** Is Named A Changemaker Fellow

Andrew Crotty Wins A Google PhD Fellowship

Wilson Cusack's Senior Thesis Becomes A Gates Foundation-Funded Project

De Stefani, Epasto, Riondato, And **Upfal** Win A Best Student Paper Award At KDD 2016

Tim Edgar Travels To Germany To Testify In The Snowden Inquiry

Esha Ghosh And **Tarik Moataz** Have Been Chosen For The 2017 IEEE Security And Privacy Student Program Committee

Trent Green Wins The Randy F. Pausch Computer Science Undergraduate Summer Research Award

Amy Greenwald Helps Coordinate The Inaugural Artificial Intelligence For Social Good Conference

Maurice Herlihy And **Eli Upfal** Are Appointed To Named Chairs

Jeff Huang And Colleagues Receive An NIH R01 Grant For Predicting Mental Health Issues From Social Data

Jeff Huang Wins An NSF CAREER Award For Modeling User Touch And Motion Behaviors For Adaptive Interfaces In Mobile Devices

MIT Technology Review Includes Research From The **Humans To Robots Laboratory** In Its 2016 Ten Breakthrough Technologies

Seny Kamara Has Been Appointed To An NAS Committee On Law Enforcement And Encryption

Seny Kamara Has Been Chosen As A Boston Global Forum Dukakis Fellow

Seny Kamara's Invited Talk On Encrypted Search At A Recent CCC Workshop Previews His Fall 2016 Teaching

Brown CS Student **Youn Kim** Is Awarded A Presidential Fellowship At MIT

George Konidaris Wins An AFOSR Young Investigator Research Award

Kraska, Binnig, And Collaborators Receive An NSF Big Data Spoke Grant For Data Sharing

Brown CS Professor **Michael Littman** Has Been Named One Of The 50 Greatest Living Rhode Islanders

Littman Is An Invited Speaker For The White House's Workshop On Safety And Control For AI

Celebrating The 25th Anniversary Of **Barbara Meier**'s Groundbreaking Use Of Morphing

Pombrio And **Krishnamurthi**'s Work Has Been Selected As One Of ACM SIGPLAN ICFP's Best Papers

Brown CS Alum **Sridhar Ramaswamy**, SVP Of Advertising And Commerce At Google, Receives The Horace Mann Medal

Sherief Reda Has Been Named One Of 11 RI Innovators

Sarah Sachs Wins A Distinguished Senior Thesis Prize

Congressional Quarterly Roll Call Documents **John Savage**'s Contribution To A Historic International Cybersecurity Agreement

John Savage Addresses The Boston Global Forum On The G7 Cybersecurity Agenda

John Savage Delivers Remarks On "Cyberspace As A Medium" At The Third World Internet Conference

John Savage Gives The Inaugural Graves Distinguished Cyber Security Lecture At The University Of Tulsa

John Savage Joins Boston Global Forum's Board Of Thinkers And Works To Combat Cyberattacks In Vietnam

John Savage Meets With Vietnam's President And Thought Leaders To Improve The Country's Cybersecurity

John Savage's Recommendations For Securing Cyberspace Have Been Presented To The Japanese Government For The Upcoming G7 Summit

Stefanie Tellex Gives An Invited Talk At EMNLP 2016

Stefanie Tellex Has Been Named One Of Robohub's "25 Women In Robotics You Need To Know About"

Stefanie Tellex Receives A Sloan Fellowship

Stefanie Tellex Was A Featured Speaker At MIT's EmTech Conference

Foreign Policy Magazine Names **Tellex** And **Oberlin** 2016 Global Thinkers

Eli Upfal's Research Group Receives A Substantial Gift From Two Sigma Investments

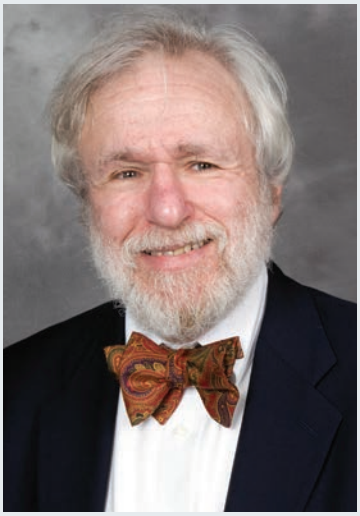
Paul Valiant Wins A Hazeltine Citation For Excellence In Teaching, Guidance, And Support

Andy van Dam Wins A Microsoft Research Outstanding Collaborator Award

Faculty Notes

EUGENE CHARNIAK

When professors take sabbaticals they are required to submit a report on what they did with them. The university has taken to making a compendium of them and putting it on line. I took a look at last year's to get some idea of how they are written, and to put it bluntly they are not the sort of thing I would recommend as gripping reading. However, my report is probably unique in that it reports on what I failed to do and perhaps it is more interesting because of that. They are also written in the third person, so that is what I did. But it is written by me, Eugene Charniak.



Eugene Charniak spent the fall semester of the 2015-16 academic year at the University of Edinburgh, hosted by the department of Informatics. The department there is perhaps unique in the world in its investment in computational linguistics, Eugene's research area, with at least seven professors in the area. (In contrast, it is rare in the U.S. for a CS department to have more than one.)

The major goal of this sabbatical was to complete a line of research on getting a machine to understand recipes. This work need not have been done at Edinburgh, but the hope was that the new environment and people to talk to would inspire new ideas. Depending on how you look at it, the research goal was or was not accomplished. It was accomplished in so far as a program was written and evaluated, as was a paper describing it. However, the paper was a bust. Eugene was never happy with it and it was rejected by the major conference to which it was submitted. It was overcomplicated, difficult to read, and had no obvious lessons on how to proceed, except perhaps, give up this line of research. Indeed, this was the lesson that was learned.

The sabbatical however turned out to be a great success, though by a route that could not have been anticipated. As with most departments, Informatics at Edinburgh is short of offices, and Eugene was not given an office for himself. Rather he shared one with one of his PhD students, Do Kook Choe, who goes by D.K. When D.K. heard that Eugene was going to Edinburgh he asked to go as well, and both Brown and Edinburgh approved. The other thing we need to bring in is that computational linguistics is undergoing a mini revolution these days due to "deep learning". Deep Learning is a new name for what used to be called "neural nets", a machine learning technique that uses computational models of neurons. It was popular back in the 1980's, but it failed to live up to its promise, and was supplanted by other machine-learning paradigms.

However, since then several new techniques have been added to the mix, and the greatly increased computer power we now have available has allowed people to try things that previously would have been thought absurdly wasteful of computational resources. With its concentration of faculty in the area, the department at Edinburgh has an invited speaker series devoted to computational linguistics, and almost all of them turned out to be applications of Deep Learning. Both D.K. and Eugene were impressed by this, and D.K. decided to

try the techniques in his research, thus drawing in Eugene. By the time they returned to Brown, D.K. (a fast learner) had already implemented one failed attempt, and Eugene (much slower) was plowing his way through on-line tutorials on the topic.

If we now fast-forward a few months, D.K.'s research has flourished due to this new infusion of ideas. He and Eugene have just submitted a paper to another major research conference, and this paper is short, easy to digest, and establishes a new benchmark in the area of computer parsing of natural-language. (Think sentence diagramming.) And Eugene is now preparing to teach a course in Deep Learning this coming Fall.

SORIN ISTRAIL

In April, 2016, Sorin attended at California Institute of Technology a symposium honoring the memory of professor Eric Davidson of the Division of Biology. Sorin did his postdoctoral studies in Molecular Biology with Eric Davidson and collaborated with him for 15 years. Professor Davidson gave the John von Neumann Lecture in Biology at Brown in 2010. From Pasadena, Sorin went to Los Angeles for the RECOMB 2016 Conference, the 20th anniversary meeting. The RECOMB (International Annual Conference on Computational Molecular Biology), arguably the top conference in computational biology and bioinformatics, was founded in 1995 by Michael Waterman (USC), Pavel Pevzner (UCSD), and Sorin.

In May, Sorin attended the ODSC Big Data conference in Boston and then traveled to Uppsala, Sweden, for the Keystone Symposia "Understanding the Function of Human Genome Variation".

In June, he attended Alberto Apostolico's memorial conference in Venice, Italy; his lecture was based on research with his former student, Doug McErlean (Google), and was titled "Variations on a theme of Alberto: A big data theorem and algorithm for the maximum likelihood haplotype phasing problem and graph theoretic symmetries of the likelihood function". At the conference, Sorin had an emotional reunion with Professor Giorgio Ausiello of University of Rome after 33 years. In 1983, Sorin and his family emigrated from (communist) Romania to Rome on their way to the US. Without any western currency money in the Rome emigration ghetto, Sorin called Professor Ausiello and asked for help: Professor Ausiello had edited that year a volume of Lecture Notes in Computer Science where Sorin published a paper. Professor Ausiello came to see Sorin's family: he opened his wallet to help them and then invited Sorin to give a talk at the University of Rome. He obtained 70 dollars as a honorarium, which was then something like a million liras; he returned back to his family as a hero. Thank you, Professor Giorgio Ausiello: you are an inspiration for all of us!

In October, Sorin gave a talk titled "Logic Functions of the Genomic cis-regulatory Code" at a symposium honoring the memory of Eric Davidson at the Marine Biological Laboratory, in Woods Hole, MA.

In November, he attended Albert Meyer's retirement symposium in the Laboratory for Computer Science at MIT. Sorin did his post-doctoral studies in Computer Science with Albert Meyer.

In December, Sorin and the Department of Computer Science hosted professor Donald Knuth of Stanford University, who gave two extraordinary lectures: the 2016 Paris C. Kanellakis Memorial Lecture and a John von Neumann Lecture.

Three of Sorin's undergraduate honor thesis students graduated in May with high distinction: Daniel Seidman went to Cornell for graduate studies in Genetics, working with professor Andy Clark, a Brown alum and Sorin's mentor; Sam Crisanto joined Microsoft Research in Cambridge, MA; and Youn Kim went to MIT for graduate studies in Computer Science, receiving a Presidential Fellowship.

Top to Bottom// Julie Nguyen Brown, In Memoriam!

Graduating students and Sorin: Sam and Youn are the first two from left, and Daniel is last

Reunion after 33 years: thank you, grazie, Professor Giorgio Ausiello!

Top to Bottom// Bob Dylan, Nobel Prize and Bioinformatics

December, 2016: Donald Knuth Days at Brown: Johnny, Don, Vincent, Sorin and Doug

ANDY VAN DAM

Andy's idea of a lazy summer vacation: biking in Switzerland, where he also gave a talk on NuSys at the Swiss Embassy

A weather forecast for East Burke, VT, on Columbus Day weekend, where we find Andy among the leaves

Andy with US Ambassador to Switzerland Suzi LeVine ('93 with a ScB and AB, Engineering (Mechanical/ Aerospace) and English) and her husband, Eric, at the Residence in Bern, Switzerland

Recent PhDs

THIS PAGE CLOCKWISE FROM TOP LEFT

Max Leiserson

Genevieve Patterson

Alexander Kalinin

Geoffrey Libin Sun

Joe Gibbs Politz

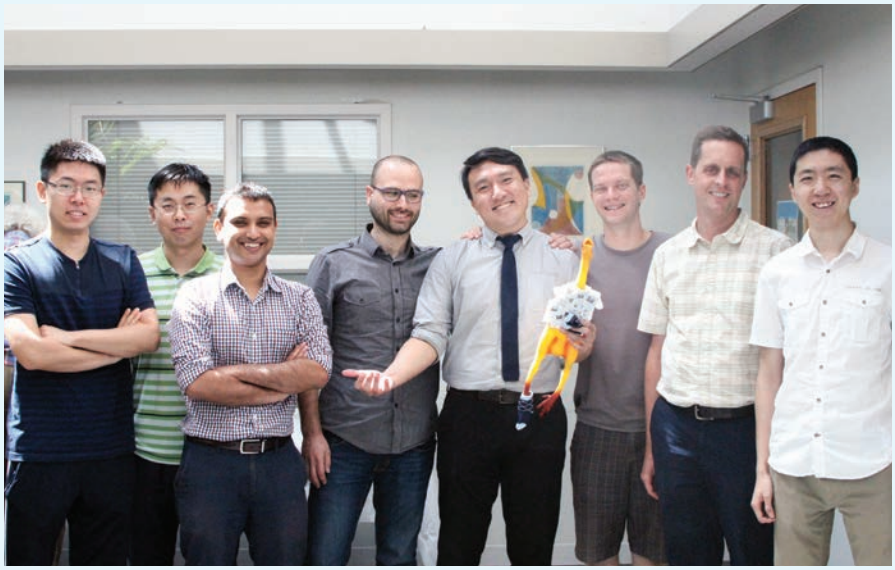
THIS PAGE CLOCKWISE FROM TOP LEFT

Ryan Cabeen

Hsin-Ta Wu

Dae Il Kim

Michael Hughes



Around The Department

Mark opens a goody bag of gifts from Brown CS

At the 2016 Tech Fair

Ugur Cetintemel thanks Mark Dieterich for his years of service as Mark takes on a new role: Director of IT Security for CIS

Mark says good-bye

Above // Kielan Donahue and Laura Case do some "pear" programming

Left // Barb Meier at the CS 125 final screening and wrap party

Left // The TAs of CS 17

Oliver Hare, Gabriel Bankman-Fried, and Gianluca (Luke) Pane play some speed chess

Scott Houde, Shriram Krishnamurthi, and Tom Doeppner

Baxter and Advik Iyer Guha at the Undergraduate Research Symposium

Libby Zorn and Taylor DeRosa

The Great Precarious Filesystem Shift

by John Bazik

For almost 30 years, a tour of CIT 531 was a rite of passage for new technical staff members. The windowless room, nestled inconspicuously among grad student offices, was the beating heart of the Computer Science Department's computing infrastructure. Filesystems, backups, networking, email, the modem pool, SSH, VPN, DNS, FTP, LDAP, Kerberos; it was all there. Today, it is no more.

In the early days, the fifth floor datacenter was little more than a chilly room with a folding table, a handful of machines, and lots of backup tapes. As technology and the department evolved, room 531 grew dense with racks and cables. Services that once ran on a single high-end Sun Microsystems server (affectionately named godzilla) were spread across scores of inexpensive PCs running Linux, dubbed a "Redundant Array of Thrifty Servers" or RATS.

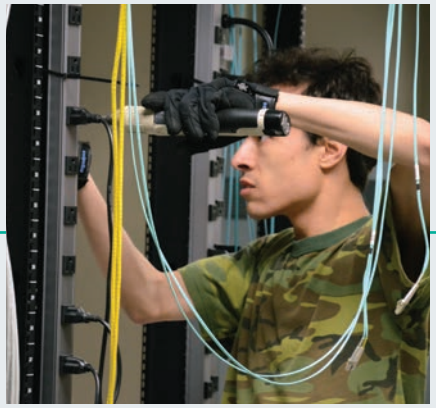
But evolution takes no prisoners, and the commoditization of datacenters and the ubiquity of virtual machines have made machine room operations the computing equivalent of growing your own food. Fortunately for CS, Computing and Information Services (CIS) has entered into that business and offered the department access to their virtual machine infrastructure and space in their datacenter. It was an offer we couldn't refuse.

The morning of May 23rd, 2016 unfolded with more than a hundred machines humming away in room 531. During the past weeks and months, the technical staff had moved many services to the CIS cloud, but our most critical resource, the IBM GPFS filesystem cluster with nearly half a petabyte of storage, remained. The 32 machines and racks of disks are rarely turned off and never all at once (at least, not intentionally). A power failure in 2015 that outlasted our UPS caused disks to fail and the cluster required serious tstaff tlc. The failure of three disks in an array would mean total data loss and weeks of downtime.

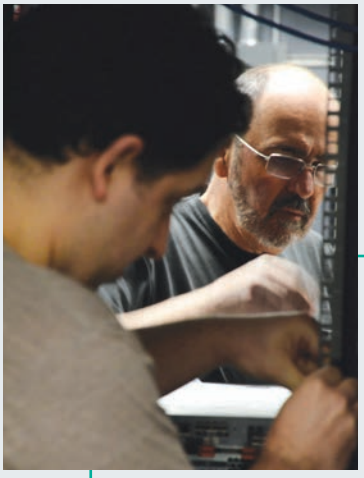
Work began at 5:45am as all services but the web and list servers were shut down. With the stakes so high, it was agreed that no one would move the GPFS machines but senior hardware tech Max Salvas. Eighteen hours later, the filesystem spun back to life in its shiny new digs. The almost issue-free move is chronicled in a blog post from that day at http://tsb.cs.brown.edu/2016/05/23/great-gpfs-move/.

Room 531 before the move

Donald Johwa gets started on the NFS servers



Ben Nacar pulling rails

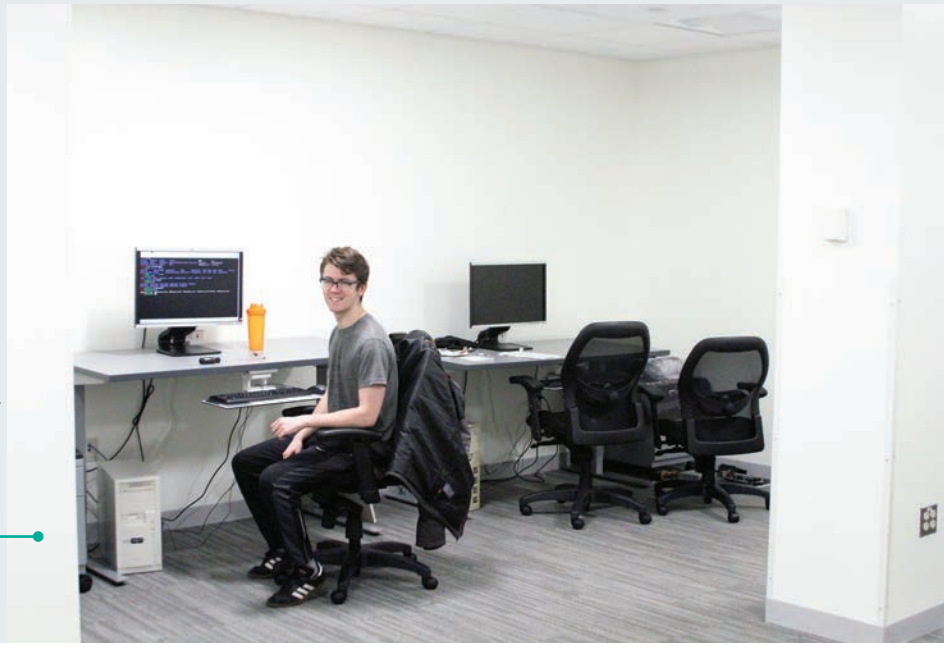


Our new home in CIS' datacenter

Above // Frank Pari and Max Salvas set up a datacenter rack

Above // Phirum Peang and Max Salvas rack a server

Below // The crew restores services at the end of a long day



Master's student Sam Dooman relaxes in the new CIT 531

Alum Updates

ADAM LEVENTHAL FINDS A HUGE CONTINGENT OF BROWN CS ALUMS AT THE SYSTEMS WE LOVE CONFERENCE

"Enthusiastic" is an adjective often applied to Brown CS alums, but it might fall short when attempting to describe the ethos of the Systems We Love conference, which was founded by alum Bryan Cantrill '96 and held in San Francisco on December 13. "Do you become unusually fascinated by the inner workings of systems?" he writes. "Do you become uncontrollably intrigued when systems fail? If so, you might suffer from a love of systems, an affliction whose symptoms can include arcane bedside reading, hard-to-explain demos and befuddled family members."

Alum Adam Leventhal was an attendee at the extremely wide-ranging event, which was designed for admirers of everything from icons in Haiku to message queues in illumos to Huffman coding in qzip. "It wasn't surprising to find such a large contingent of Brown CS alums," he writes. "It was a great endorsement of the systems education provided by twd, Pascal, JJ, and the rest, and a talk from Jordan Hendricks even mentioned how Tom's operating systems classes have inspired a love for systems throughout the years."

To learn more about the conference, go to: https://systemswe.love

Back row, from left: David Pacheco, Keith Adams, Bryan Cantrill, Michael Demmer, Adam Leventhal, Daniel Hoffman, Ardra Hren, and Cody Mello. Front row, from left: Oliver Hurst-Miller, Alex Kleiman, Jordan Hendricks, Robert Mustacchi, and Jordan Place

LAURA LARK GETS AS CLOSE TO MARS AS ANYONE CAN

Alum Laura Lark (Laura Parkinson, when she was at Brown) has been chosen for a mission that may prove to be an important step in humankind's quest to someday explore Mars. We offer a brief preview below, and we're looking forward to remotely interviewing Laura from her new home (a geodesic dome on the slopes of Mauna Loa on the island of Hawai'i) once the mission gets underway.

Five years ago, the University of Hawai'i at Mānoa's NASA-funded Hawai'i Space Exploration Analog and Simulation (HI-SEAS) was founded on the premise that we need to better understand human behavior and performance in space before we continue our journey outward in the solar system. How will today's researchers function with 20-minute communication delays, or get the right form of exercise, or prepare food from only shelf-stable ingredients?

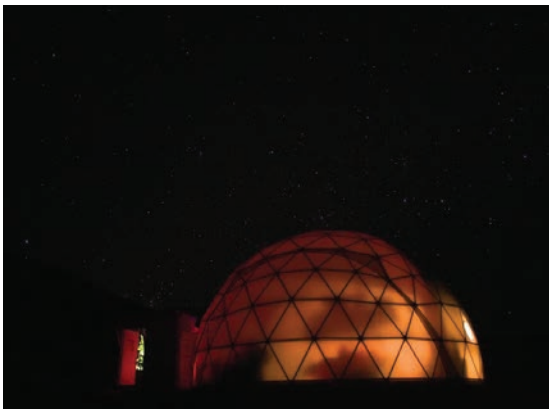
On January 19, 2017, HI-SEAS Mission V began when six crew members, including Laura, entered their geodesic dome with the goal of helping determine the individual and team requirements for long-duration space exploration missions. Remaining in the dome for eight months, they'll undertake eight primary and three opportunistic studies, working with scientists who are at the top of their fields worldwide.

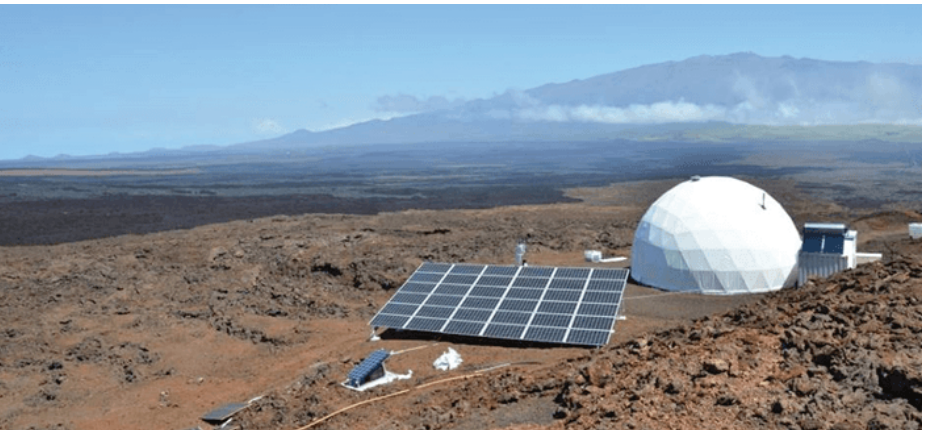
Being chosen for the mission is a high honor in light of the importance attached to finding "astronaut-like" candidates. "HI-SEAS is scientifically distinct from studies on other teams operating in ICE (isolated, confined, and extreme) environments, such as the Antarctic base," Laura explains, "because crews can be specifically chosen to be similar in composition to how we imagine crews of the early missions to Mars might be. Crew selection is one of the major focuses of the current round of missions. I'm definitely looking forward to spending a lot of time with my crew — they're a bunch of awesome people. I'm also really looking forward to working with them to figure out ways to deal with the challenges that arise. I got into CS because I love problem solving, and to some degree I was interested in HI-SEAS for the same reason."

Inside their 13,000-cubic-foot dome, complete with a 10kW solar array and a hydrogen fuel cell generator for backup power, Laura's team will be participating in pioneering research in areas as diverse as dynamic multimodal monitoring (sociometric badges will capture physical, physiological, and behavioral data about crew members) and virtual reality (crew members will play a collaborative game to assess individual and team behavioral health and performance).

Luckily, Laura comes prepared. “I’ve found my experience in the UTA program to be incredibly valuable throughout my career,” she says, “including here. The UTA program is relevant to the mission in that I need to become part of a well-functioning team with people I don’t necessarily know very well, decide together how we’ll accomplish our major tasks, then implement them.”

Good luck, Laura! We’re looking forward to hearing from you from inside the dome. Readers can find out more about Mission V here: http://hi-seas.org/?p=6175





Upper Left // The slopes of Mauna Loa, not unlike Mars

Upper Right // A blueprint of the dome

Lower Right // The dome at night

Lower Left // The dome and an impressive solar array

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Staying In Touch

- Send a blank email to alumsubscribe@cs.brown.edu to join the Brown CS Alum Email Group, which we'll use to occasionally share updates. It's only for alums, and members can't e-mail each other, so you don't need to worry about a high volume of messages.
- Visit our web site (www.cs.brown.edu), which we update daily with news and stories
- Visit (and please be sure to like) our Facebook page (www.tinyurl.com/browncsfb)
- Follow us on Twitter (www.twitter.com/browncsdept)

Industry Partners Program

The IPP provides a formal mechanism for interactions between companies and students in the CS Department. Member companies benefit from superior visibility in the Department, exclusive access to event/interview space in the CIT Building and assistance with recruiting events; students benefit from specific information about opportunities for summer internships and permanent employment.

The department wishes to thank our Industrial Partners for their support:

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Google
Jane Street
Microsoft
MongoDB
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Yelp

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IXL Learning

Start-Up/Small Company
FiveStars
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pMD
Vision Systems
VoltDB

Individuals
Paul Edelman,
Edelman & Associates

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