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The Magazine of the Carnegie Mellon University School of Computer Science

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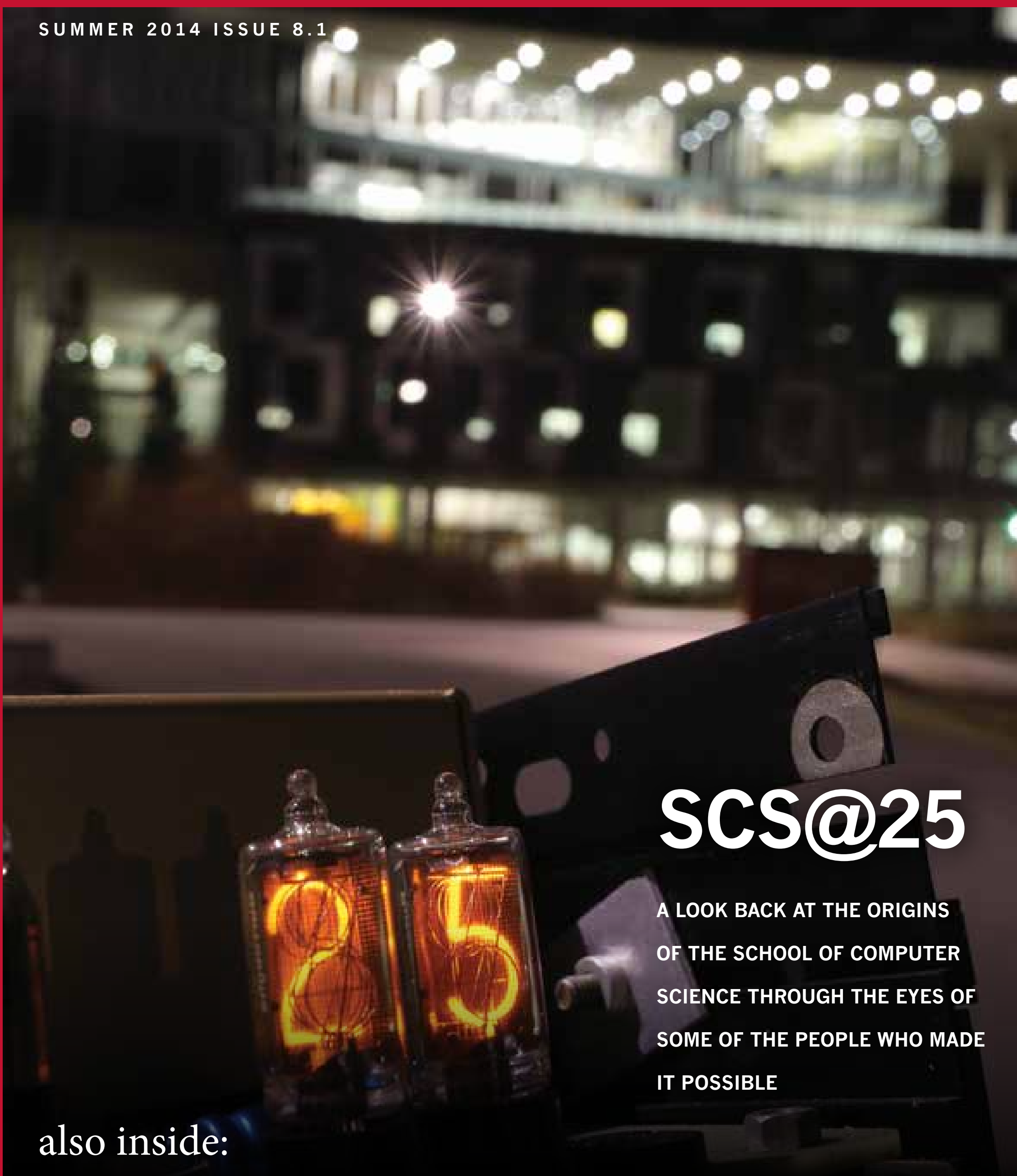

SCS@25

A LOOK BACK AT THE ORIGINS OF THE SCHOOL OF COMPUTER SCIENCE THROUGH THE EYES OF SOME OF THE PEOPLE WHO MADE IT POSSIBLE

also inside:

OUR NEW DEAN HAS A FAMILIAR FACE

TOUGH ROBOTS TAKE ON ANOTHER DARPA CHALLENGE

RESEARCH NOTEBOOK: KINETICA ALLOWS USERS TO ‘PLAY WITH DATA’

Carnegie Mellon University

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The Link provides a mosaic of the School of Computer Science: presenting issues, analyzing problems, offering occasional answers, giving exposure to faculty, students, researchers, staff and interdisciplinary partners. The Link strives to encourage better understanding of, and involvement in, the computer science community.

Editor-in-Chief
Randal E. Bryant

Editor
Jason Togyer

Contributing Writers
Tina M. Carr, Meghan Holohan, Nick Keppler, Philip L. Lehman, Linda K. Schmitmeyer

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Graphic Design
Communications Design & Photography Group

Office of the Dean
Gates Center 5113
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213

Randal E. Bryant, dean

Tina Carr (HNZ'02), director of alumni relations

Philip L. Lehman (CS'78,'84), associate dean for strategic initiatives

Byron Spice, director of media relations

Jason Togyer (DC'96), editor

Phone: 412-268-8721
Email: TheLink@cs.cmu.edu
Web: www.cs.cmu.edu/link
Facebook: facebook.com/SCSatCMU
Twitter: twitter.com/SCSatCMU

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on the cover

Cover photo by Wade H. Massie

Dean Randal E. Bryant

25 years and counting

This year, we're celebrating the 25th anniversary of the founding of the School of Computer Science. Of course, computer science was well established at CMU by 1989, but the formation of the school was a strong statement to the world that CMU viewed computer science as being worthy of a prominent position within the university.

The initial steps in forming SCS occurred shortly after I arrived at CMU in 1984. As a junior faculty member, I was shielded from most of the controversies and concerns that arose during that time.

Fortunately, the wisdom of the decision to form SCS is now clear to everyone. SCS has demonstrated that computer science has both great intellectual depth and an astonishing breadth of impact. Computer technology has become pervasive and critical to every aspect of our personal activities, our businesses and our governments. By bringing together many different foundational disciplines—mathematics, engineering, social science and more—students and faculty in SCS can address all facets of this remarkable technology.

Our ventures into such areas as robotics, human-computer interaction, human language technology and computational biology have demonstrated the value of approaching many different real-world challenges from a computational perspective. In addition, the formation of SCS provided the impetus for us to create our own undergraduate program, and this has inspired us to put education, at all levels and across many disciplines, as a major focus for our efforts.

It's exciting to see how far we've come in 25 years, and how much further new opportunities can lead us!

Randy Bryant

Randal E. Bryant
Dean and University Professor
School of Computer Science

FEEDBACK LOOP

First-ever?

In your news item (Fall 2013, p. 36) about Randy Bryant stepping down as dean of SCS, you said his sabbatical will be his first-ever. If I remember correctly, Randy spent a year at Fujitsu in Japan around 1990. He studied Japanese for like an hour every day for a year before going, but as soon as he got there, they said his Japanese wasn't very good and put him in a Japanese class. His kids were pre-school age, and picked up Japanese quickly, but lost it fairly quickly upon return to Pittsburgh.

In any case, Randy certainly deserves another sabbatical.

Duncan "Hank" Walker (CS'85,'86)
Department of Computer Science and Engineering
Texas A&M University

Editor's Note: We asked Randy about this. He says you're correct about his year (1990-91) in Kawasaki, Japan, but because he was actually a "Visiting Research Fellow" at Fujitsu, it wasn't officially classified as a sabbatical. P.S.: Domo arigato for your letter.

The Link welcomes corrections, comments, bouquets and brickbats. Write to The Link Magazine, Office of the Dean, School of Computer Science, Carnegie Mellon University, Pittsburgh, PA 15213 USA, or email TheLink@cs.cmu.edu. Be prepared to explain what a "brickbat" is.

Tough tasks for a tough robot

CMU's CHIMP is headed to the finals of DARPA's Robotics Challenge, where it will perform nimble jobs in areas designed for humans

By Meghan Holohan

The task appears simple. Walk through three doors. That means grasping the handle, turning it, and pulling or pushing the door before passing through it.

Most of us do that every day, without much thought. But for CHIMP—the CMU Highly Intelligent Mobile Platform—this requires a lot of practice.

Its "eyes" must look at the door and send video back to a human operator who's controlling CHIMP from a trailer. From the grainy 3-D images, the operator must assess the situation and tell CHIMP what to do. Is it a doorknob or a door lever? How should CHIMP grasp it? Does the door push out or swing in?

CHIMP was created at Carnegie Mellon's National Robotics Engineering Center by a group called the Tartan Rescue Team. It exists—in part—because of the Fukushima nuclear plant disaster. On March 11, 2011, a tsunami struck the east coast of Japan's most populous island, Honshu, damaging the Fukushima Nuclear Power Plant and eventually leading to a meltdown of three out of six nuclear reactors. With radiation at alarming levels, it remains impossible for human workers to enter much of the facility. Several robots have entered the plant to gather information and data, but some of those robots failed mid-mission and were abandoned.

In 2012, the U.S. Defense Advanced Research Project Agency created the DARPA Robotics Challenge. Teams were challenged to create semi-autonomous robots that could do "complex tasks in dangerous, degraded, human-engineered environments." The tasks include driving a vehicle intended for humans, navigating terrain, climbing a ladder, moving debris from a doorway and walking through it, opening and passing through doors, cutting a triangle out of a wall, closing a valve and attaching a hose.

CHIMP, the CMU Highly Intelligent Mobile Platform, attempts to connect a hose to a connection during the DARPA Robotics Challenge Trials in Homestead, Fla.


Spectators at the DARPA Robotics Challenge Trials watch the robots compete.

During trials held in Homestead, Fla., in December 2013, CHIMP navigated a human-sized environment with ease, earning enough points to move into the final round of competition, scheduled for later this year. One of 11 robots headed to the final round, CHIMP placed third in the trials, ahead of some formidable opponents, including robots from Johnson Space Center and MIT. (Tartan Rescue wasn't the only CMU-related team to reach the finals. A team fielded by Worcester Polytechnic Institute, which includes CMU roboticist Christopher Atkeson and six CMU grad students or post-docs, finished seventh in the same competition. See sidebar.)

CHIMP certainly shares some characteristics with its namesake animal. It has two long arms and a strong back. The red robot also looks vaguely human. It stands on two legs, but instead of feet, it rolls on tracks like those of a tank; it also has tracks on its forearms, so it can bend down and drive around like an all-terrain vehicle. Cameras perched on its squat, square head give the robot two sets of eyes for 3-D imaging.

"The advantage of a humanoid robot, given its human form, is that it can fit into human spaces and do things humans do," says Tony Stentz, NREC director and leader of Tartan Rescue.

A robot that can stand on two legs and maneuver in spaces where humans normally work could help clean up nuclear disasters or shimmy into tight spaces in mines and factories. But many of the existing bipedal robots aren't advanced enough to perform human tasks like opening doors or turning valves, which is why DARPA introduced the challenge. The competition pushed teams to develop a robot quickly. "It was a very ambitious goal, but not impossible," Stentz says. "We like challenges. They're fun, and they motivate the team to work hard."

In October 2012, CHIMP existed only as a concept on a piece of paper; NREC didn't have a humanoid robot under development. And it was what NREC didn't have that made the contest so important, says Herman Herman, principal NREC commercialization specialist.

"In order to be relevant, we needed to design a humanoid robot," says Herman, who serves as sensor pod and electronics lead for CHIMP.

Teams in the Robotics Challenge could enter in one of four tracks. In track A, teams whose proposals were accepted received $3 million to both build a robot and design its software. In track B, teams received $1 million and developed software only for the existing Atlas robot, made by Boston Dynamics. "On the plus side, you don't have to build you own robot," Herman says. "On the minus side, you have to live with (the robot's) shortcomings." (Tracks C and D received no DARPA funding. The WPI-CMU team competed in Track B.)

Because Tartan Rescue was designing and building a robot from scratch, and was on an accelerated schedule, the

Continued on page 6

A robot that can stand on two legs and maneuver in spaces where humans normally work could help clean up nuclear disasters or shimmy into tight spaces in mines and factories. But many of the existing bipedal robots aren't advanced enough to perform human tasks like opening doors or turning valves, which is why DARPA introduced the challenge.

WPI-CMU ROBOTICS TEAM IS HOT ON CHIMP'S HEELS

On the heels of Tartan Rescue's CHIMP in the DARPA Robotics Challenge trials was another robot with CMU involvement—WARNER, a humanoid robot entered by Worcester Polytechnic Institute. Four members of the WARNER team are from CMU's Robotics Institute, including Chris Atkeson, a professor of robotics and human-computer interaction.

But there's no rivalry with Tartan Rescue, Atkeson said. And like the CHIMP team, he expects the finals to be "much more challenging."

WARNER placed seventh in the DRC Trials at Homestead-Miami Speedway, securing points for climbing a ladder, walking on rough terrain, manipulating a hose and turning valves. Also significantly, WARNER drove a Polaris Ranger all-terrain vehicle 250 feet in six minutes, the fastest time of any robot in the trials. The WPI-CMU team received the "Best in Task Vehicle Award" as a result.

The WPI-CMU team is using the 6-foot-2, 330-pound Atlas robot developed by Boston Dynamics. The principal investigator on the project is Michael Gennert, director of the Robotics Engineering Program at WPI, where he also serves as professor of computer science and electrical and computer engineering. Atkeson serves as a co-principal investigator along with Taskin Padir, an assistant professor of robotics engineering and electrical and computer engineering at WPI.

"My group is particularly interested in locomotion—walking, climbing the ladder, and getting into and out of the car," Atkeson said. Using the Atlas robot allows the CMU group to focus on software and not worry about building or maintaining a custom robot, he said.

The disadvantage is that the WPI-CMU team can't customize the robot for its approach, or the tasks that the DARPA challenge demands, Atkeson said.

"The driving task was one of the most demanding from a testing standpoint, and our team really did an outstanding job," Matt DeDonato, who leads the WARNER team, said after the December trials. "We couldn't be happier for the effort the team put forth on that task and throughout the competition." Driving was considered a key part of the challenge, because first-responder robots can't handle any other tasks at a disaster scene unless they can get to the disaster scene.

"The team is thrilled with the finish, and we're looking forward to continuing to train WARNER for the next competition," DeDonato said. "It's been quite a ride for everyone, and I'm confident that we're up for this next challenge."

Atkeson said this is his first collaboration with Gennert and the WPI researchers. "They did very well on the simulation phase of the DARPA Robotics Challenge, and then invited me and my group to join them," he said.

The CMU team collaborates with its colleagues in Worcester during weekly virtual meetings using Google Hangouts and periodic on-site, in-person visits, Atkeson said.

In case you're wondering, WARNER isn't named for CMU's administration building, Warner Hall. The name is an acronym for WPI Atlas Robot for Non-Conventional Emergency Response.

You can follow the WPI-CMU team, and see video of WARNER in action, at http://robot.wpi.edu/drc/.

—Jason Togyer (DC'96)

The WPI-CMU team is using the 6-foot-2, 330-pound Atlas robot developed by Boston Dynamics. The team placed seventh in last year's DRC Trials.

CHIMP can stand on its rear legs or roll on tracks like an all-terrain vehicle, as shown here.

Continued from page 4

team had to make some tough choices. Many of the decisions were constrained by time and money.

"I just say 'no' a lot," says David Stager, the systems engineering lead and senior NREC commercialization specialist. He's joking, and adds that all of the decisions were made after careful deliberation: "I've been trying not to close out really good ideas."

To earn all 32 points in the Homestead trials, a robot needed to finish each of eight assigned tasks in 30 minutes. The first thing the Tartan Rescue team had to decide was whether CHIMP would compete in all the tasks. Stager and Clark Haynes, CHIMP's software lead and senior robotics engineer, balanced the value of the points against the amount of effort it would take to develop the necessary software. They decided that CHIMP would compete in only enough tasks to win 20 points.

It was a risk. Could CHIMP be competitive if its design didn't allow for all 32 points? But the team wanted to design a robot that played to NREC's strengths: engineering and building solid yet sophisticated industrial robots and field vehicles. Although a humanoid robot, CHIMP's design is informed by NREC's experience making other, non-humanoid robots, Herman says.

At 5-feet-tall, CHIMP is squat, but it has a powerful build, weighing in at 400 pounds. That makes it the heaviest robot in the competition. Being such a big robot provided CHIMP with an advantage—it was the only robot in the trials that didn't stumble and fall. During testing, CHIMP was commanded to move a two-by-four piece of lumber. Due to operator errors, CHIMP used its gripper to drive the wood right into a concrete-block wall. The robot didn't budge. And it didn't drop the lumber. "The wall fell over—but CHIMP didn't move," Haynes says.

Being a brute of a bot poses other challenges as well. "As you try to make a robot more capable, it gets heavier," Stentz says. "Our biggest concern is that CHIMP has to drive a vehicle. That's where a bigger, bulkier robot has a disadvantage." Driving a vehicle was one task left out of CHIMP's initial design; the team decided it would be too difficult to design and program a robot for driving in the short amount of time available.

"We knew what points we could get," Stager says. "This year (2013) was about getting to be one of the top teams."

CHIMP also didn't get all the points for the ladder challenge. It earned one point for stepping onto the ladder, but it wasn't designed to climb it.

The two teams that earned first and second, Schaft Inc. and IHMC Robotics, both worked with existing robots; Schaft, a Japanese startup company recently acquired by Google, used its own HRP-2 robot, while IHMC used the Atlas robot. Considering CHIMP was little over a year old, it did remarkably well. "I actually think that CHIMP is one of the best-designed robots in the competition," Stager says.

But the team now faces another challenge—improving CHIMP to compete in all the tasks. The eight top teams won $1 million to upgrade their robots for the final competition. While the Tartan Rescue team is glad to have the money, Stager estimates they need about $5 million to $6 million to get CHIMP into competition shape. "This technology is really expensive to develop," he says.

If the team attracts additional money, it will thoroughly upgrade CHIMP for the finals. If it doesn't, it will improve the software and make sure the same robot can compete in all eight tasks. Although the tasks in the finals are expected to be similar to those in the December 2013 trials, the team expects they'll have an added level of difficulty. All of the robots in the trials were tethered to off-board power supplies, and Stentz suspects DARPA will require the robots to compete without tethers. As of this writing, DARPA has not yet released all of the details of the final competition.

—Pittsburgh-based freelance writer Meghan Holohan is a regular contributor to The Link whose stories also appear at the Mental Floss and MSNBC websites.

Training teaching's technologists

HCII's newest master's program gives students in-depth experience with the latest educational tools and techniques

By Linda K. Schmitmeyer

It's an eclectic group.

There's a master violinist who, as an intern, designed industrial training courses for workers building cars at China's Dong Feng Motor Corporation.

There's a Stanford University graduate, fluent in Italian, who taught chemistry and physics at Pittsburgh's Ellis School.

There's a mechanical engineer who researched decision making in complex systems for Singapore's Defence Medical and Environmental Labs.

There's a high school special education teacher, who, as an undergrad majoring in accounting and information science at SUNY Oswego, developed online courses.

And there's a software developer with an information and communication technology degree from India's DA-IICT, whose resume includes a graphic that shows how many hours he devotes to daily tasks.

These are the Carnegie Mellon University graduate students who make up the Capstone Project team for the new Master's in Education Technology and Applied Learning Science, or METALS, program. The inaugural class enrolled in fall 2013.

A 12-month professional degree, METALS is offered through SCS's Human-Computer Interaction Institute and the Dietrich College's Psychology Department.

"METALS will help build learning engineers," says Michael Bett, associate director of the master's degree program, which is only the second in HCII. "These students will graduate being able to use evidence-based research to develop curricula or courses for companies that say, 'This is the best process for going forward,'" he says.

Mark Potter

The interdisciplinary program is an outgrowth of the research conducted by the NSF-funded Pittsburgh Science of Learning Center, better known as LearnLab. METALS includes faculty from human-computer interaction and psychology, but also has electives from other parts of campus. It's intended to give students the tools necessary to design, develop and implement advanced teaching and training methods, using the latest technologies and techniques.

"It's an extremely unique program," says Mark Potter, the high school special education teacher. "It's cutting edge, and we are learning the latest learning sciences research and using the most recent educational methodology."

The METALS program also melds with CMU's recently launched Simon Initiative, a university-wide effort, named for the late Herbert A. Simon, to accelerate the use of learning science and technology to improve student learning. "Part of the Simon Initiative's goal is to emphasize student-learning outcomes, and we want to create students who can go out into the world and to other universities and companies and design solutions and technologies that greatly improve student-learning outcomes," says Ken Koedinger, professor of human-computer interaction and director of the METALS degree program.

At the heart of the METALS degree is the 32-week Capstone Project, which gives students the opportunity to work with a real corporation and get first-hand experience from the process of researching and developing a new product.

This team's client is BloomBoard, an EdTech company that provides an online growth-development platform for K-12 educators. It recently expanded from Silicon Valley to a second office in Pittsburgh.

Their assignment is to explore ways to help build professional learning communities for teachers, in an effort to improve results in their classrooms.

"Engaging talented CMU students, especially those with such a strong focus on education, was a priority from day one," said Tony Bellino, who runs BloomBoard's East Coast operations. "The METALS students continue to exceed our expectations and we couldn't ask for a better team."

Just a few weeks into the Capstone Project, in early February, the students were meeting with Koedinger and John Stamper, an HCII systems scientist. Sitting around a conference table in Newell-Simon Hall in early February, their laptops open and a Google Doc projected onto a pulled-down screen at one end of the room, the students were in the early stages of their project.

They met with faculty twice weekly throughout the spring semester to stay on top of the various aspects of their project, which included reviewing the latest published data on professional teacher development, preparing for (and conducting) field research, interviewing BloomBoard customers and potential users, and analyzing competitors' programs.

At this early February meeting, they were discussing their plan for exploratory research: the phone and contextual interview questions; the algorithm for coding responses; and the targeted audiences, a mix of urban and rural and public and private school teachers throughout the United States. Hearing the plan, Koedinger reminded the students of the importance of pacing the different phases of the project. "Your plan is very ambitious, and I hate to discourage you from being too ambitious, but you may need to narrow your focus," he says.

Stamper and Koedinger offered numerous suggestions on interviewing during the 80-minute meeting, such as the importance of coding their interviews for later retrieval, spot-transcribing the contents, asking questions that elicit stories, rather than "yes or no" answers, and tracking compelling quotes.

"They've been a great help, because none of us have worked in this capacity or have had industry experience before," Potter says. "They're there to guide us on the questions to ask, which research methods work best, what people we should be talking to."

Koedinger says the process for developing a new educational product is rigorous. "The students do field research in the spring, where they go around talking to customers or new potential users of the product," he says. "By the end of spring, they'll create a highly professional document that reports on what they discovered and what their design ideas for the new product are. Over the summer, they'll do repeated interactive designs of that software product that's been through cycles of improvement."

Martina Pavelko

It's that rigor that attracted Martina Pavelko, the Stanford University alumna, to the METALS program. She was uninspired by the traditional master's in education programs offered by other universities.

"I wanted something that was a little more forward-looking, a little more technically driven," Pavelko says. "METALS is very practical and recognizes the realities of a really technological world, where there are more devices in a house than there are family members."

Koedinger calls the approach of HCII's Capstone Project courses "unique, even within Carnegie Mellon." Other universities have programs involving corporate sponsorship, says Koedinger, "but HCII's $80,000 participation fee insures higher levels of involvement from industry participants. On the METALS project, BloomBoard staff work closely with their student team, including three face-to-face meetings during the eight-month project and weekly videoconferences."

In addition to the METALS' Capstone Project, there are 13 other projects currently going within HCII's other master's program, the Master's in Human-Computer Interaction, Koedinger says.

Does the experience pay off for industry partners as well as students? Koedinger thinks so: "In the end, our corporate sponsors will get a product that's not far from what they'd get if they hired a consulting firm for $200,000." →

—Linda K. Schmitmeyer is a freelance writer and editor and teaches at Point Park University's School of Communications.

> Engaging talented CMU students, especially those with such a strong focus on education, was a priority from day one. The METALS students continue to exceed our expectations and we couldn't ask for a better team.
>
> *—Tony Bellino*

For NEIL, seeing can mean comprehension

CMU's Never-Ending Image Learner is scanning the Web to build its own database of facts and connections

By Nick Keppler

ConceptNet is the most advanced semantic network ever to come out of the Massachusetts Institute of Technology. It contains more than one million facts shoveled into it by thousands of online contributors who—since 1999—have built the system up en masse, Wikipedia-style.

But last year, when researchers tested it using questions from the Wechsler Preschool and Primary Scale of Intelligence Test—questions such as, "Why is ice cream kept in the freezer?"— ConceptNet turned out to be about as smart as a four-year-old child.

"Better algorithms could get the results to (the) average for a five- or six-year-old, but something new would be needed to answer comprehension questions with the skill of a child of eight," the University of Illinois team concluded.

Despite sci-fi predictions about artificial intelligences becoming dangerously smarter than humans, researchers have so far found few ways to teach computers those millions of little bits of information that make up common sense—aside from just feeding them facts, one by one, a process slower and less comprehensive than the way a young human learns.

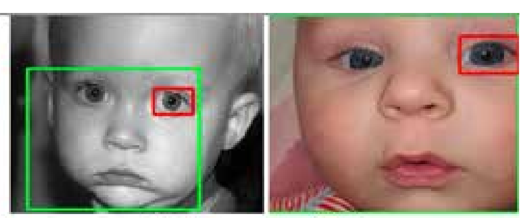
That's led to computers that can beat chess champions, but which don't understand bits of common sense that can't be deduced by algorithms and mathematics, such as the fact that pencils are used for writing, or that cups hold liquids.

Tom Mitchell, Fredkin University Professor of Computer Science and head of CMU's Machine Learning Department, attempted to find a better way. Since 2010, his Never-Ending Language Leaner, or NELL, has since been scanning the Internet 24 hours a day, seven days a week, trying to deduce relationships between nouns extracted from a collection of more than 1 billion Web pages. Some of NELL's recent epiphanies: "newborn photography is a form of visual art," "cilantro citrus chicken is a food," and "Ernie Hudson is a male." (You can follow along as NELL learns at twitter.com/cmunell.)

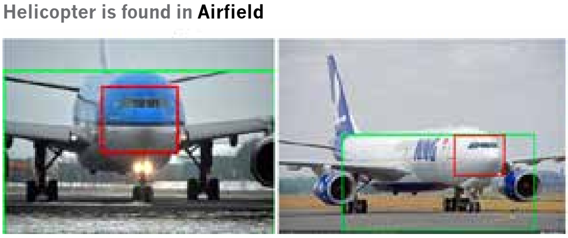
But we don't learn everything—or even most things—about the world around us from written words, says Abhinav Gupta, assistant research professor at the Robotics Institute. We learn many things visually, and some of the things we learn are so obvious to us, we take them for granted.

Visual common sense relationships learned by NEIL

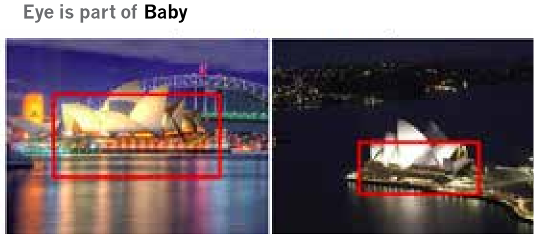
Helicopter is found in **Airfield**



Eye is part of **Baby**



Airplane nose is part of **Airbus 330**



Opera house is found in **Sydney**

Tom Mitchell

Xinlei Chen

"Some things are so basic they aren't put into words," he says. "No one is going to say 'the white sheep' because we all understand that most sheep are white. In fact, there are more references to 'black sheep' out there, because that is a phrase" that plays on their uniqueness.

To study how computers can learn from visual information as well as language, Gupta, Abhinav Shrivastava, a Ph.D. student in artificial intelligence and robotics, and Xinlei Chen, a Ph.D. student in the Language Technologies Institute, have created the Never-Ending Image Learner, or NEIL, whose virtual kindergarten is the sea of pictures available online. Since July 2013, NEIL has been searching the Web for images related to nouns—provided either by NELL or by Gupta and his team—and is using the pictures to infer relationships.

The program understands five broad kinds of relationships: "can have a part," "can be/can have," "can be found in," "can be a kind of/look similar to," "can be an attribute of." For example, when NEIL was presented with the word "tires," the program searched for images marked with the term. After scanning countless images of tires, it concluded that "wheel can be a kind of, or look similar to tire," "tire can be, or can have, black and "tire can be, or can have, round shape."

With an ever-evolving base of knowledge, NEIL is always discovering relationships between nouns new and those already familiar to it. It has so far deduced 3,000 relationships between 2,500 concepts.

Gupta says the image-scanning NEIL is able to grasp things lost on the language-absorbing NELL: "NEIL knows what 'white' looks like, and recognizes that whiteness is an aspect of most sheep."

Like NELL, NEIL is not always correct. Misidentifying a yellow billiard ball, the program concluded that a set of pool balls have a part that is "lemon," and, bafflingly, thinks a "bridge can be a part of (an) eggplant."

Also, some concepts just stump it. "I don't think NEIL will ever understand what cheese is," says Gupta. "Cheese comes in too many colors and shapes for NEIL to comprehend it."

As for homonyms, NEIL is able to cluster images into different sets if it senses the pictures related to the word come in more than one distinct shape. Under its entry for "bass," a few clusters are of fish and a few are of musical instruments.

The point of the project is to study how a computer can learn independently, a process that's crucial to someday developing an artificial intelligence smarter than the average kindergartener. "We are learning how a computer (could) answer questions," says Chen, who spent much of last summer writing code for NEIL.

A browse through the nouns being studied by NEIL reveals some of the outside interests of Gupta, Chen and Shrivastava. Terms they entered into NEIL "just for fun" include Batman, Yoda, Iron Man, Xindi (a race of aliens from "Star Trek: Enterprise") and a variety of specific car models (new and vintage).

Sci-fi-style computers that can learn independently are probably decades, if not centuries, away. But Mitchell says the research being done with NEIL and NELL has the potential to change technology already in use, starting with Web search engines.

"Right now, a search engine reading the Web is like you or me reading a book in Swahili," Mitchell says. "We could find a certain phrase if we looked over every bit of text, but we would have no idea what it meant." A more advanced search engine would understand something about the terms for which it was searching. A researcher in an obscure field might type her terms into a search engine, and be able to find everyone working on similar projects—even if they weren't described in exactly the same words.

"It would reinvent search engines as we know them," Mitchell says, "if search engines not only found the words you were looking for, but understood the text, and therefore the answers to your queries."

—Nick Keppler is a Pittsburgh-based freelance writer whose work has appeared across the country in alternative newsweeklies such as St. Louis' Riverfront Times and the Village Voice. He wrote about surgical robots and model checking in the Fall 2013 issue of The Link.

New dean has a familiar face

Longtime faculty member Moore returning from Google Pittsburgh to lead SCS

By Jason Togyer

The appointment of Andrew W. Moore as the fifth dean of the School of Computer Science marks a homecoming of sorts for the longtime member of the CMU faculty. Moore went on a leave of absence from CMU in January 2006 to become founding director of the Pittsburgh office of Google Inc.

University President Subra Suresh announced Moore's appointment April 15 before about 200 faculty and staff members and students in Room 6115 of the Gates Center. He called the new dean "particularly well positioned" to lead SCS.

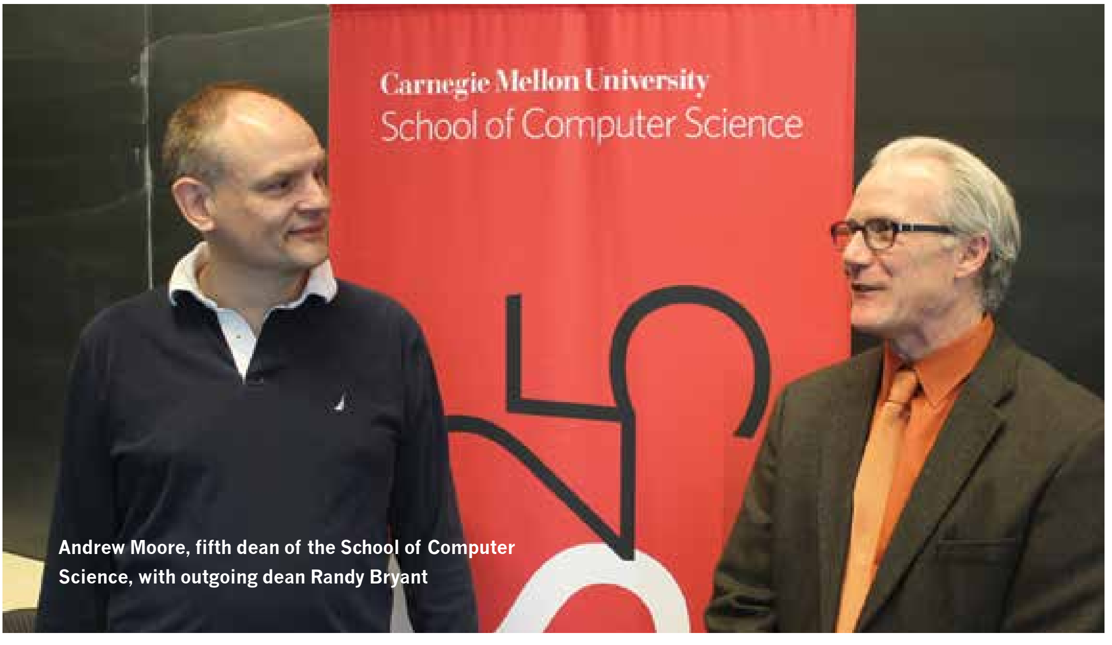
Moore "combines an expansive vision, scientific expertise, and leadership strength that make him extraordinarily well suited to be dean," Suresh said. "As computing grows ever more critical to our global society, the scope of SCS and its importance to the world will continue to expand and its impact on the human condition will be more evident."

A member of the faculty since 1993 and a professor of computer science and robotics, Moore, 49, succeeds Randal E. Bryant, who is stepping down June 30, 2014, after two full terms as dean to return to research and teaching.

While at Google, Moore led projects to improve user experiences in advertising and shopping and to help combat fraud. In October 2011, while continuing to serve as leader of Google's Pittsburgh office, Moore was named vice president of engineering of Google Commerce, where he became responsible for developing new products and services.

Moore's tenure at Google Pittsburgh was characterized by the office's rapid growth both in size and importance to the company. Google Pittsburgh started with just two employees in a rented office on the CMU campus. It now includes more than 275 employees in 140,000 square feet in East Liberty's Bakery Square development, located just a few miles from Carnegie Mellon. Work being done at Google Pittsburgh includes everything from the company's signature search engine to shopping, advertising and the Android mobile platform.

Eric Schmidt, executive chairman of Google and a former member of the CMU board of trustees, said he expects Moore to "inspire the next group of innovators" at SCS. "Some of Google's strongest talent has come out of CMU, and we look forward to continuing our relationship with the university," Schmidt said.



Andrew Moore, fifth dean of the School of Computer Science, with outgoing dean Randy Bryant

Faculty and staff react April 15 to CMU President Subra Suresh's introduction of Andrew Moore as the new dean of the School of Computer Science.

Moore's research interests broadly encompass the field of "big data"—applying statistical methods and mathematical formulas to massive quantities of information, ranging from Web searches to astronomy to medical records, in order to identify patterns and extract meaning from that information. His past research has also included improving the ability of robots and other automated systems to sense the world around them and respond appropriately.

From 2002 to 2005, Moore served as co-director of the Biomedical Security Center at the University of Pittsburgh, and along with Michael M. Wagner and Ron M. Aryel, he was editor of the Handbook of Biosurveillance, a guide to detecting and fighting outbreaks of communicable diseases in real-time.

In 2005, Moore was named a fellow of the Association for the Advancement of Artificial Intelligence for his significant contributions to machine learning, data mining and statistical artificial intelligence, as well as for his role in transferring those technologies to industry and government.

A graduate of the University of Cambridge, where he studied mathematics and computer science, Moore was born in Bournemouth, U.K., Jan. 15, 1965, and began his career working for Hewlett-Packard's Bristol research lab. He returned to Cambridge in 1986 to earn his Ph.D. in computer science.

Moore spent three years as a post-doctoral researcher at the Massachusetts Institute of Technology before joining the CMU faculty. From 1995 to 2001, Moore served as co-founder and chief technology officer of a small, Pittsburgh-based consulting company specializing in data mining technology. He lives in Pittsburgh with his wife, Mary, and two children, William and Lucy.

In addition to Bryant, deans of the School of Computer Science have included founding dean A. Nico Habermann, Raj Reddy and James H. Morris (S'63).

screenshot

TO THE VICTOR, BELONG THE TILES

As his opponent dawdles over the Scrabble board, Victor becomes impatient. “Playing you is like painting grass and watching it dry as it grows,” he says.

Once his opponent plays a word, Victor is scornful: “This is not golf—you want a high score.”

Seated on the third floor of the Gates Center, Victor is a Scrabble-playing robot, or “gamebot,” developed under the leadership of Reid Simmons, research professor in the Robotics Institute. Victor is the latest in a series of experiments (see “Making a Mechanical Pal,” Spring 2011 issue) studying how people engage with social robots—machines that seem to have personalities. Since making his debut, Victor has become something of a celebrity, being featured in The Wall Street Journal and on TV.

The work could have implications for robots taking on more serious tasks—helping people with physical challenges to live independently in their homes, for example. “We believe that for autonomous robots to be accepted, they will have to conform to the social conventions of people, rather than the other way around,” Simmons says.

Victor’s torso is topped with a video screen displaying his animated face, the work of Anne Mundell, associate professor in the School of Drama. Victor’s “character” was created by Michael Chemers, formerly at CMU and now an associate professor of theater arts at the University of California at Santa Cruz.

Other contributors include Maxim Makatchev (CS’13), robotics post-doc; Greg Armstrong, RI senior research technician; and numerous undergraduate and graduate students.

The team chose to give Victor a bit of an attitude—“edgy enough to be engaging, but not so much that people don’t want to play,” Simmons says. Victor’s also not a very good player, despite his high opinion of himself.

People “don’t care if they lose to each other, but they don’t want to lose to a machine,” Simmons says.

—Jason Togyer (DC’96)

in the loop: ken koedinger

Ken Koedinger is a professor of human-computer interaction and psychology at Carnegie Mellon University. A graduate of the University of Wisconsin at Madison with a B.S. in math and computer science and an M.S. in computer science, he earned his Ph.D. in cognitive psychology at CMU in 1990. Koedinger is a co-founder of Carnegie Learning Inc. and leads LearnLab, the Pittsburgh Science of Learning Center. He is the creator of Cognitive Models—computer simulations of student thinking and learning that are used to guide the design of educational materials, practices and technologies. Cognitive Models provide the basis for an approach to educational technology called Cognitive Tutors that support learning within rich problem-solving environments. He spoke to Link Editor Jason Togyer.

Where did you grow up?

Mostly the Milwaukee area of Wisconsin—where Herb Simon grew up.

What was your first computing experience?

In high school we had a programmable calculator—I'm sure my iPhone is thousands of times more powerful than it was. Later, as an undergrad at the University of Wisconsin, I got into environmental and biological system modeling on the Apple II. That was fun because you could access the memory of the Apple II directly with "peek" and "poke" commands—remember those? Other students in my class also had made computer models, and I built a generic simulation that could dip into any one of their models and modify the variables from a graphical user interface, without modifying their code.

What excited you about technology growing up?

I was captivated by the questions of "How do people do smart things?" and "How do people solve complicated problems and learn flexibly?" Those are great scientific problems, and computer science—through artificial intelligence—was providing a way to model them. Math and science came easy to me, but at the same time, I was interested in the social sciences, and I wanted to do something that would make a difference. Education is at the root of a lot of human problems. Dig into any social problem—war, poverty, hunger—and ultimately, you find that if people were better educated, they would be much easier to address. So I also was taking a lot of philosophy and psychology courses to study how people learn.

What attracted you to Carnegie Mellon?

I was very impressed with what was happening in computer science with Herb Simon, and in psychology with John Anderson, who became my mentor. John was doing basic science on how people think and learn while also working on applications. He was working on intelligent tutors that could teach LISP programming and high school geometry, and that was a perfect fit for my interests, because it combined understanding intelligence with doing something good in the world.

What about this process of "thinking" is so interesting?

We are far from cracking the mystery of how people learn, and why they're so flexible and powerful in their thinking. The idea that Newell and Simon had—that if you have a good theory about thinking, you should be able to build a program that can replicate it—remains a big challenge. The "age of the machines" may be coming, but it's going to be 20 or even 30 years before we have to worry about Skynet. Statistical methods have shown us how to learn categories and classify things, and made reasonable progress in natural language processing, but we're not yet at the stage where systems can learn how to reason on their own.

Artificial intelligence has moved from using rules-based models to statistical models. Is there a shift back toward rules-based models?

I'm not sure that a "shift back" is the right way to say it. There are still some real mysteries that will require us to go back and revisit more symbolic, traditional approaches that Newell and Simon started with, but it won't be instead of using machine learning. They'll be a hybrid. The human mind is a statistical engine that soaks up patterns, but it also possesses conscious perception of the world, which we call reason. We don't really understand yet the interface between the two, and we don't have computer systems that can replicate it.

There were plenty of computer programs that were designed to teach skills. What made cognitive tutors so much more powerful than those?

The old message of psychology, going back to Freud, is that you don't really know yourself—that so much is going on beneath the surface in the subconscious. We don't know what we know. The key to cognitive tutors is that we start out by discovering, through data collection, what human experts really know. They can't tell us. The

Ken Koedinger with his 6-year-old daughter

two separate and equally challenging questions are, what it is that you're trying to get students to do? And what teaching strategies work with the human brain to get them there?

What are some things we thought we knew about teaching, but which aren't really true?

Well, algebra teachers for years have said students have the most trouble with story problems. We did a study comparing students who solved story problems with those who solved the same problems as matched equations, and we were really surprised—and so were math teachers—to find students did better with story problems than with matched equations. It reflected a lack of conscious understanding by teachers that they didn't realize how much they knew about equations. It's not just because they forgot—it's because their brains have been working on the problem, subconsciously, over time. They've learned the language of algebra the same way you learn any other language.

We're in the 10th year of the Pittsburgh Science of Learning Center. What have we learned?

The traditional approach to understanding what students need to learn involved interviewing experts, and was very labor-intensive. We've learned that we can use machine learning methods and data collection to make that a more efficient, scalable process. We now have more than 500 different data sets of people using intelligent tutors to learn language, science and math from kindergarten through college. The data repository and tools we've developed are helping researchers and course developers discover how students think and learn.

How will this sort of data inform the human teaching model 100 years from now?

We're going to see less lecturing and more apprentice-style "learn-by-doing." The reason we don't have more learn-by-doing already is that there's a scalability issue. Massive open online courses are very powerful and scalable because they're focused on verbally delivering content-knowledge through lectures. But a lecture only gets at 30 percent of what you need to know to become an expert in a topic. To learn by doing, you need to be able to practice with feedback. You can get indirect feedback by doing homework and seeing the teacher's comments the next day, but it's not very efficient. If you have a one-on-one tutor, whether it's a person or a computer, you can let your brain do its powerful soaking up of knowledge through practice, but you can also be guided and get some instruction when you're stuck.

You taught in an urban high school. How was that experience?

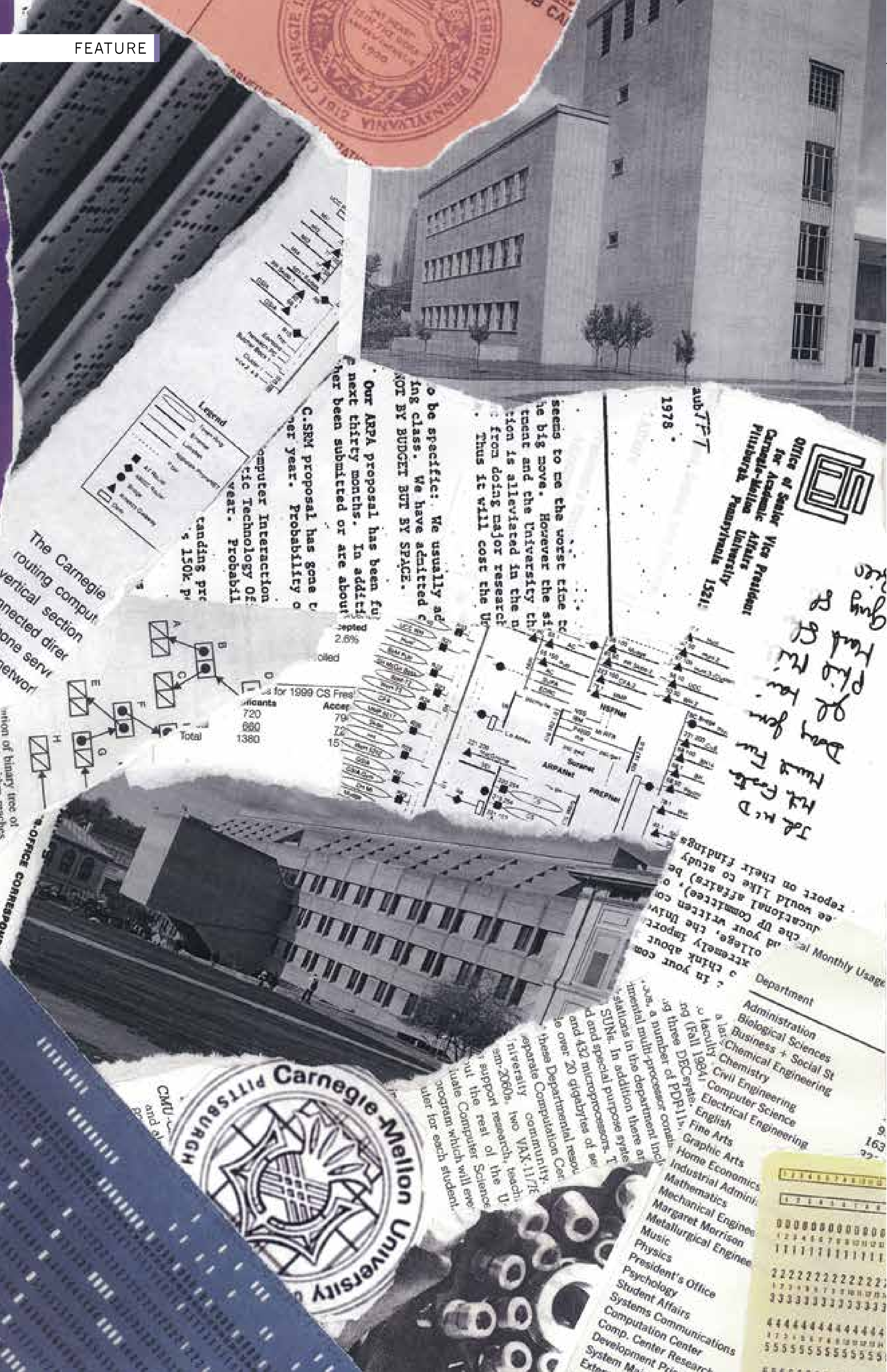
I taught in Langley High School here in Pittsburgh as I was finishing my thesis. It wasn't a very long experience, but it was incredibly eye opening, and my respect for teachers and the teaching profession—which was already high—continued to grow. It's incredibly hard. Classroom management alone is very challenging, beyond the instructional challenges we've been discussing.

What do you like about teaching?

You see a student struggling, you figure out how to help them, and then you help them succeed. The satisfaction of programming is similar, right? You say, "I can't get this computer to do this task." But eventually it works, and it's very satisfying. Teaching is a much harder task, but it's also about seeing a student go from struggling to achieving. That turnaround is very satisfying.

What do you do for fun?

I work out on my elliptical. That's fun—in an odd sort of way. I also play the guitar, and I have two daughters who are 6 and 2, and the 6-year-old is learning to play the piano, so my fascination with music is continuing.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Computation Center

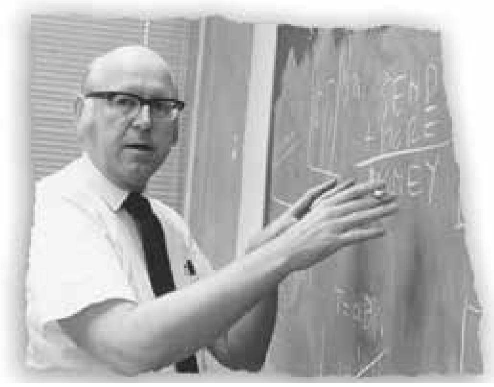
Institutional memories: Reflections on a quarter-century and more

The School of Computer Science is celebrating its 25th year as a stand-alone college within CMU. We asked some of the people involved with that milestone to tell us the story in their own words—and to predict what comes next.

By Jason Togyer

The computer science era at Carnegie Tech began in 1956, with the arrival of the university's first computer, an IBM 650 with magnetic-drum memory and a speed of approximately 60 instructions per second. Herb Simon (H'90), associate dean of the Graduate School of Industrial Administration—now known as the Tepper School of Business—established Tech's first Computation Center with the help of its first director, Alan Perlis (S'42).

JIM MORRIS, S'63 (Professor of Computer Science): Simon, in retrospect, remade the university starting in about 1950. I think of him as the intellectual founder of our current university, because he brought in Allen Newell from the RAND Corporation, and he recruited Alan Perlis. That was the famous threesome that arguably created computer science nationally.



Allen Newell

ALLEN NEWELL, IA'57 (U.A. and Helen Whitaker Professor of Computer Science, interviewed in 1991): Computing comes to CMU, a highly technical college, and it comes to GSIA. They are the people who embraced it, mostly because the characters at the other end of the campus didn't have the good sense to decide that they wanted the computer down in their environment.

MORRIS: Schools such as Harvard and Penn and some places in England had an engineering jump in computer science, but Simon was a social scientist. Simon came out of an operations research tradition during the second World War, when they were thinking of computers much more as a tool than as a thing to be "built." He and Newell pushed a much broader perception of what computer science was going to be, and it was more about using computers than building them.

NEWELL (1991): The whole early part of this thing at GSIA (was) loaded with concern for management science. No concern with numerical computing; total concern with sort of non-numerical stuff ... concern with human behavior was very much involved.

MORRIS: Simon said, "Look, this computer thing is going to be big, and it's going to be used for a lot more than just numerical calculations. It's going to be used for everything, and it's going to remake corporations." In that way, they got the whole university—GSIA, psychology, humanities, social sciences—energized about computers.

Allen Newell's quotes are taken from a 1985 interview conducted by Sara Kiesler and Lee Sproull, found in the CMU archives, and from a 1991 interview conducted by Arthur L. Norberg for the Charles Babbage Institute. The quotes have been lightly edited for context and consistency. The 1985 interview may be found at http://doi.library.cmu.edu/10.1184/pmc/newell/box00074/fld05194/bdl0004/doc0001 and http://doi.library.cmu.edu/10.1184/pmc/newell/box00074/fld05194/bdl0003/doc0001. The Norberg interview may be found at http://hdl.handle.net/11299/107544.

In 1956 and 1957, Simon, Newell and Cliff Shaw of RAND designed the Logic Theorist, a computer program that could discover proofs for theorems. They also developed linked-list data structures, the foundation of computer programming. In 1958, Perlis began teaching the first freshman-level computer programming course in the United States at Carnegie Tech.

Jim Morris

MORRIS: I was sitting in the fraternity house, having a beer, and a friend walked in and said, "I'm taking a course with this crazy bald-headed guy. It's a night course, but he says anyone who wants an 'A' can get an 'A.'" I said, "Well! That sounds like a very interesting subject to me!" (Laughs.) It was Alan Perlis, who was evangelizing computing at a very early stage. It was an exciting set of ideas, and I was sitting here as an undergraduate, having no clue that I was part of a revolution.

In 1961, the Computation Center and its then-new Bendix G-20 were moved to recently completed Scaife Hall. That same year, Carnegie Tech created an interdisciplinary Ph.D. program called Systems and Communications Sciences, combining elements of computer science, mathematics, psychology, business and electrical engineering. The university's first computer science Ph.D.s were graduates of this program.

NEWELL (1991): It had its own graduate students, probably about 15. They all lived in the Computation Center, and it was fueled by DARPA funds, independently of anything else. From my point of view, DARPA never had any plans for us. We were just supposed to go be "excellent."

MORRIS: In the 1960s, a guy at DARPA named J.C.R. Licklider said "I'm going to create computer science departments, and I'm basically going to do it by spending a lot of money." His chosen method of doing that was to call up his friends at MIT, Carnegie Tech and Stanford, give them money, and say, "Go do computer science."

NEWELL (interviewed in 1985): You have to know something about the 1960s. In the 1960s, the norm was to get money. I didn't say the norm was to entrepreneur it—the norm was to get it … Everything (at DARPA) was oriented toward providing scientists with funds. And the same thing was true at NIH.

MORRIS: This was happening in universities all over the country. The Defense Department and the National Science Foundation were force-feeding money into universities, and Carnegie Tech got itself right in there.

The department emerges

In 1965, Carnegie Tech established its Computer Science Department with a $5 million grant from the R.K. Mellon Foundation. Perlis was the first department head.

MARY SHAW, CS'72 (Alan J. Perlis University Professor of Computer Science): 1965 is the beginning of time as we know it. I graduated from Rice, and not too long after I was admitted to the (Carnegie Tech) interdisciplinary program, the (CS) department was formed. The whole enterprise was small—probably a half-dozen faculty.

NEWELL (1991): I don't think I even knew that we became a department. I never attended a single meeting to discuss it. Al (Perlis) and I talked about it a couple of times. We agreed it was sort of the right thing to do. Al went off and did it.

ANGEL JORDAN, S'52, E'59 (Emeritus University Professor of Electrical & Computer Engineering and Robotics): It was only Ph.D.s—no master's students, no undergraduates, and it was supposed to have a heavy dose of research, research, research.

Mary Shaw

In 1967, Carnegie Institute of Technology merged with the nearby Mellon Institute of Industrial Research to form Carnegie-Mellon University. The Department of Computer Science would move into the Mellon Institute of Science, later renamed Mellon College of Science, or MCS.

SHAW: The curriculum at that time was, "take courses for two years and then look for a research advisor." The class that entered in 1968 essentially staged a palace revolution. They said, "This is not what we came to graduate school for—this is more like an undergraduate program." And Al Perlis, to his great credit, said, "Well, let's try it another way."

NEWELL (1985): The whole structure of our program was set in 1969 because we had this student revolt. Now, there you (have) what has got to be, historically, an atypical response. Faculties do not normally respond to that.

SHAW: The critical path to the degree is the student figuring out how to do research, and what we know about critical path analysis says that you want to get started on the critical path as early as possible. That's one of the insights that led to the curriculum change, and we haven't lost sight of it. We still match up students with research advisors, essentially as soon as they arrive, and we expect them to be doing research right away.

NEWELL (1991): We ended up with a place where graduate students picked people to work with without concern for whether they get funded totally and completely … All you had were people doing science. Not little fiefdoms. It was all community. All because there weren't any financial constraints on people.

SHAW: We were over in Porter Hall then—I believe we had both floors of what was then the "new" addition, and part of where Civil Engineering is now. The Computation Center and the department were very much one entity—the Computation Center staff were contemporaries of the students, and the offices were intermingled. Most of us were single. Someone would go down the hall and say, "It's dinner time, who's coming?" and a mix of students and staff would go out.

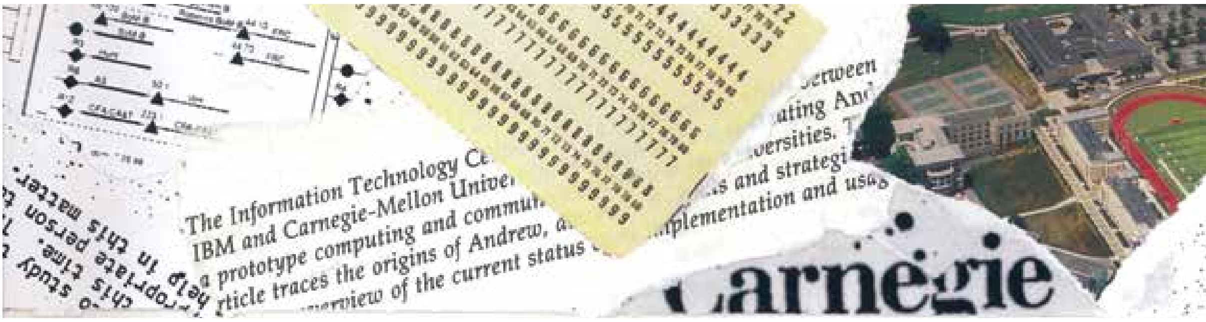
DAN SIEWIOREK (Buhl University Professor of Electrical and Computer Engineering and Computer Science): I joined the faculty in 1972. When I was a graduate student at Stanford, word was that at CMU, collaboration was in the water, in the air. You could get world-class people to collaborate on something that was in their area of expertise and get something greater than the sum of the parts.

In the 1960s, Jordan was a professor of electrical engineering at CMU. He became head of the Electrical Engineering Department in 1969.

JORDAN: Alan Perlis eventually went to Yale, but prior to leaving, he came up with the idea that since the Department of Computer Science was so small, and wanted to grow, while the Electrical Engineering Department was large, and not particularly interested in growing, that we would create joint appointments—associate or assistant professors of both electrical engineering and computer science. It was a very good idea—in fact, a stroke of genius—because poor Computer Science, with only seven or eight faculty members, was able to grow, and grow significantly. A number of great people came—Bill Wulf (H'99), for instance, was one of our early luminaries, along with Gordon Bell (H'10).

Raj Reddy joined the CSD in 1969 after three years as an assistant professor at Stanford. He brought with him research in speech, language and computer vision. But in 1970 and 1971, the new Computer Science Department faced its first crisis, as half of its tenured faculty members—including Perlis—left for other universities. Joe Traub, a professor of computer science at the University of Washington, was recruited to CMU to become the new department head.

JOE TRAUB (Edwin Howard Armstrong Professor of Computer Science, Columbia University): The department was still a jewel even though half of the faculty had left, and my number one priority



was, “Got to hire some faculty.” I invited 30 people here that first year. At one point, Raj Reddy came to me and said, “You’re wearing out the faculty,” because we were interviewing sometimes four or five people in one week … one of the people we hired that first year was Dan Siewiorek.

SIEWIOREK: When I got here, I was one of those 50/50 appointments in CS and EE. It was an attempt to get the departments to work closer together. We had, I think, 10 faculty members, and there was a great degree of cooperation. John Grason (E’65, CS’70), along with Gordon Bell, developed something called PDP-16 register transfer modules. Those allowed a junior-level class to build a PDP-8 class minicomputer in one or two labs, which was really unheard of at the time. Things were very exciting here.

TRAUB: They were working on some very sexy stuff here with parallel processing, for instance. And even though they had lost some faculty members, Allen Newell and Herb Simon were still here, and they were giants. Some people have big reputations when you look at them from afar, but Allen Newell—what you saw from afar was what you got up close … And I didn’t have a fear about (office) space, because Science Hall (now Wean Hall) was brand new. The first thing I did was get us moved out of the old offices into Science Hall in July of ’71.

Shaw organized and led CSD’s first Immigration Course that fall while finishing her doctoral thesis.

SHAW: I remember getting permission to take some classroom chairs from somewhere over in Porter Hall so that we could have seats for the first day of classes in the new building. I rounded up some other students and a dolly, and we went and moved chairs one evening, because it was easier than getting it done by official means.

TRAUB: The thing about Carnegie that was so different from other universities was that it was so easy to get things done—to make joint appointments, for instance … I like to build things—I build institutions and I build theories. But I like to build new things so that I don’t have to follow someone else’s rules.

SHAW: I joined the faculty when I graduated in 1972. There was work on programming language design, better ways to build compilers and operating systems research. AI was concerned with problem solving and chess, things like that. We had four faculty members interested in “programming languages,” which is what software people were called at the time.

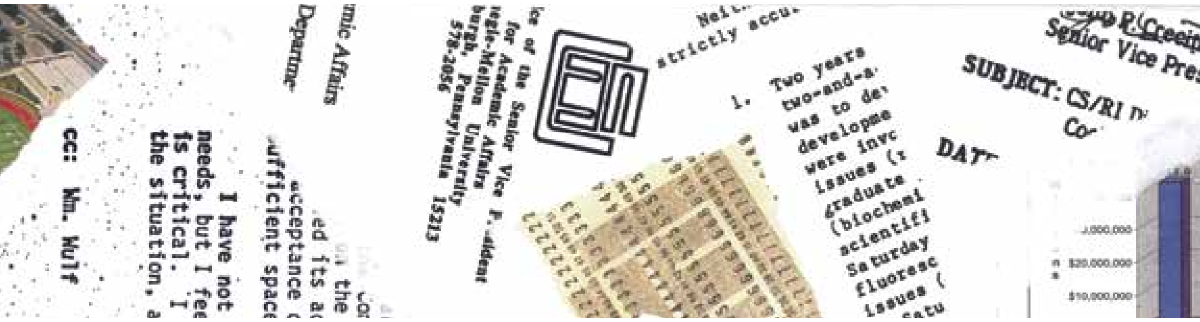
JORDAN: Our DARPA funding started to be significantly augmented with the help of Allen Newell and Raj Reddy. As Raj and others became prominent in the Department of Computer Science, they also had tremendous influence in other departments, such as Psychology, and later had influence elsewhere, such as the College of Fine Arts. It became quite interdisciplinary.

TRAUB: Our total budget for the department in 1971 was $2 million—$1.8 million from DARPA, and $200,000 from CMU—in 1971 dollars. We were really spoiled, but we did good work!

‘Greening up the campus with computer science’

Several large projects emerged in the Computer Science Department, including C.mmp, the first shared-memory multiprocessor computer, with 16 processing units. Siewiorek was co-lead on the construction of Cm, a 50-processor computer. In 1975, Simon and Newell were awarded the A.M. Turing Award for their work in artificial intelligence. Three years later, Simon received the Nobel Prize in Economics for decision-making theory.*

Although Newell continued pursuing AI systems that emulated human thinking, he also became interested in human-computer interaction, and began a long relationship with Xerox’s Palo Alto Research Center, or PARC, which released the Xerox Alto in 1973. Considered a forerunner to many of the computing environments that followed, Alto featured a graphical-user interface and was among the first commercially available workstations controlled with a mouse.



NEWELL (1991): There never was a scientific publication issued on the Alto, but the Alto, in fact, was a very important thing for computer science.

RAJ REDDY (Moza Bint Nasser University Professor of Computer Science and Robotics): Newell and I used to consult for Xerox PARC, so both of us were somewhat knowledgeable about the design of the Alto. It was clear to us that we should have these machines in our environment. I went to (PARC founder) George Pake and said, "Can you give us 100 Altos?" He said, "I can probably give you five or 10." I said, "No, no, the whole place has to be supplied!" We went to DEC and they hemmed and hawed, then we went to IBM, and they said, "You don't need a separate computer for each person," and offered us some sort of a mini-computer.

With help unavailable from IBM, DEC or Xerox, Reddy launched a drive for development of CMU's own "three-M" machine—a personal workstation with a megabyte of memory, a megapixel display and at least one million instructions per second of processing power.

NEWELL (1985): There's a radical difference between computer science in the '60s and computer science in the '70s. It becomes much more project-oriented. CS in the '60s is really quite unstructured … In the '70s, the whole organization changes radically, because we were shaken up quite strongly by our sponsors. "Well," they say, "we've been supporting AI for 10 years, what have you done for us lately?"


Angel Jordan

TRAUB: Bad things started to happen in the 1970s. Our number one priority was hiring more faculty, but our number two priority was to diversify our funding, to cut our dependence on DARPA. When George Heilmeier became director of DARPA, he didn't like AI, and all of a sudden my budget went from $1.8 million in DARPA funding to $1.5 million. Wham! Well, we had an emergency plan in place. The following year, it went to $1.2 million. We managed within a year or two to get a million dollars from NSF.

One non-governmental research sponsor was Pittsburgh's Westinghouse Electric Corp., then a large manufacturing conglomerate with interests ranging from consumer products to factory automation. In 1979, Westinghouse executive Tom Murrin collaborated with Jordan and Reddy to create the Robotics Institute, with Reddy as its first director.

JORDAN: It was quite an accomplishment, and Raj Reddy was more or less the inspiration.

SIEWIOREK: Raj was like the Wild West—anything conceivable was possible. He could just go off and do anything. Have you ever heard of the "half-Raj" and the "full-Raj"? The half-Raj is when Raj says, "Dan, I'd like to talk to you," and you know it's going to be very interesting. When you get the full-Raj, he puts his arm around you, and you're going to be totally involved in a grand adventure.

JORDAN: We had to do a lot of recruiting of faculty. There was quite a lot of participation from CIT—electrical engineering, mechanical engineering, civil engineering—at one point, the Robotics Institute was kind of "claimed" by the College of Engineering. However, robotics shared its computing facilities with the Department of Computer Science. That was an incentive for the Robotics Institute to start hiring computer scientists; up until that point, all of their hires had been engineers. More and more of their faculty was coming from computer science, and more of their students also were from computer science.


Dan Siewiorek

SHAW: By then we were bursting at the seams. We were growing both the faculty and the student body at a pretty good clip.

In 1979, Traub left CMU to start a new Computer Science Department at Columbia. Office and laboratory space, scattered in Wean and Doherty halls, emerged as a serious concern for Traub's successor, A. Nico Habermann. By 1982, the Computer Science Department included more than 30 faculty members and 100 graduate students. "There are 16 faculty members who share offices," Habermann wrote in one memo to CMU President Dick Cyert. "None of the offices shared by them are suitable for double occupancy … the graduate student offices are overcrowded so severely that, in some cases, there is no room for a desk per student." Habermann told Cyert he was "at the breaking point."

REDDY: I wasn't privy to some of the discussions between Nico and the dean of science. There may have been some heated words used. Nico threatened to resign several times during his tenure as department head.

SIEWIOREK: Nico said the Computer Science Department was sort of like a torus, with a cone on top. The surface area of the torus was allowing the faculty to collaborate with other faculty members. There's a very narrow neck, which is the department head, and then the rest of the university. Nico said the department head's job was to keep the administration off of the backs of the faculty.

The lack of physical space didn't prevent the university and the Computer Science Department from establishing another new research frontier: Development of a high-speed computer network that would reach virtually every room on campus, along with a GUI-based computing environment, and providing networked PCs or workstations for 7,000 students, faculty members and employees.

REDDY: I was sitting at the airport with Dick Cyert, and I said, "Look, the Computer Science Department is going forward with personal workstations, you really ought to think about making the whole university computer-centric." Allen Newell used to call it "greening up the campus with computer science." So Cyert asked Newell to head up a committee about that idea, and it turned into the Andrew Project. We went back to IBM and DEC and asked, "Are you willing to become a partner in a campus-wide computing project?" IBM made an offer, because they realized they were in danger of falling behind.

MORRIS: I was working at Xerox PARC, and they offered me a nine-month sabbatical anywhere I wanted to go. We looked around the world and my wife convinced me that we should come back to Pittsburgh. I'd been at Xerox for 10 years, we'd developed all of this personal computer stuff—I was enflamed by the potential of it—and Xerox was going to abandon the products we'd developed. It was a sensible business decision for Xerox, but at that point, many of us were bailing out of PARC. I said, "OK, I'll take this job at CMU and try to create a system in the image of what we were doing at PARC."

REDDY: People like Jim Morris, Al Spector and Satya (Mahadev Satyanarayanan, CS'79, '83) ended up doing a lot of strong technical work on the Andrew network and the Andrew File System. One of the great things that came out of that—at the time I thought it was rather extravagant—was the idea of a centralized or cloud-based system for files. Because there was this high-bandwidth connection, anything you touched automatically got downloaded. Many of the ideas that came out of Andrew have since become kind of a global solution, and now everyone uses them.

SIEWIOREK: Satya's research continues to have an impact, and it stretches back to those Andrew File System days. The computing environment was fantastic. With Andrew, and then Wireless Andrew, our computing environment was the envy of other universities, and we were attracting world-class students.

'Software wars' and 'theory guys'

In addition to robotics and AI, research at the Computer Science Department in the early 1980s centered on *programming languages, hardware and architecture, as well as a field called "operations performance and analysis."*

MORRIS: At a certain point, a visiting committee came into Carnegie-Mellon and said, "You're great in systems and artificial intelligence, but weak in theory." So Nico went out and decided to recruit some great theory guys.

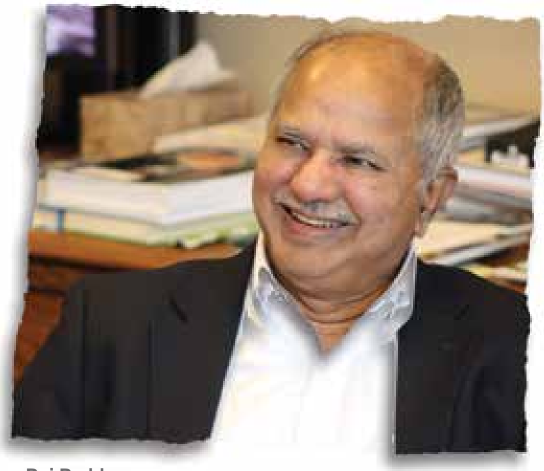
SIEWIOREK: Nico brought in Dana Scott, Dana brought in other people, and they put us on the theory map. Nico was a programming language guy, but he was also able to serve these growing, different constituencies.

DANA SCOTT (Hillman University Professor of Computer Science, Philosophy and Mathematical Logic, Emeritus): I was a professor at Oxford at the time, but the financial situation with the Thatcher government in the U.K. was very bad. Out of the blue came a letter from Nico Habermann, offering me a professorship at CMU. He said, "We are so well-provided with funds that you'll never have to write a project proposal again." Well, the very fall I came to Pittsburgh, Bob Kahn, one of the fathers of the ARPANet, came to CMU and said, "The good times are over." And the rest of the time I was there, I was trying to think of ways to write project proposals.

DARPA still had an interest in computer science—but instead of funding general research, the agency was becoming application-driven, and was funding very targeted projects. One of those was a proposed "Software Engineering Institute," which would study computer security and develop best practices in the design of operating systems.

JORDAN: Nico and I knew something big was about to happen. The proposal that we wrote said the Software Engineering Institute had to come to Carnegie-Mellon. There was competition. We did a lot of lobbying. Some people called it the "software war," but we won. And the first director of the SEI was the lead author of the proposal—Nico Habermann.

SHAW: Nico recruited me to become the chief scientist for the SEI, so I spent most of my time there for four or five years. I grew an entirely new understanding of the engineering issues of real software production, and I think it was good for me, and for the other people who have established connections with SEI over the years.



Raj Reddy

MORRIS: Nico was greatly revered by virtually everyone in the department, and I liked him a lot. He was a great teacher, he did great research, and he was the first director of the Software Engineering Institute—he made great contributions to the university.

Becoming a misfit in MCS

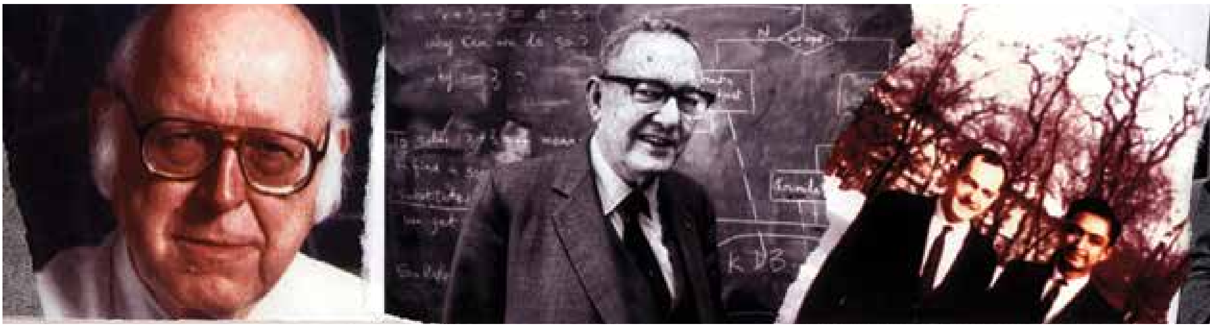
Between 1982 and 1985, the amount of sponsored research in the Computer Science Department doubled, from \$7.2 million to \$15.3 million—more than the other four departments in the Mellon College of Science combined.

REDDY: Computer Science was the elephant in the room, because their budget was like 80 percent of the college budget. And that's without the Robotics Institute, because it reported directly to the provost.

JORDAN: Yet when it came to budgeting, there were scarce resources for the Computer Science Department, and Nico Habermann was very, very unhappy—and that is an understatement.

MORRIS: It was a politically fraught issue, because the Computer Science Department was exploding with research funding—something CMU had never seen before, really. It wasn't fitting into the traditional department structure.

SCOTT: Computer Science was the tail wagging the dog, and the decisions that the Mellon College of Science was making administratively didn't always match up with our needs. Computer Science needed to have laboratories of a different kind than the so-called "wet sciences" do. Things also changed very, very quickly, so decisions had to be made very, very quickly, and the college structure was too sluggish.



SHAW: I sat on the Mellon College of Science council for a few years as the representative for Computer Science, and what was really clear was that we had a different set of issues. We didn't have an undergraduate program, so the concerns that the other departments had about staffing courses, advising, admissions and so forth were not our concerns. Other departments were worried they weren't getting enough graduate students—we were beating graduate students off with sticks. We were a misfit in MCS.

Feeling that CSD's needs were inadequately represented in MCS, Habermann and Jordan in 1986 wrote a white paper proposing the creation of "a School of Computer Science." MCS administrators and others protested loudly.

MORRIS: University politics is a sibling rivalry on steroids. If you see another department about to become a college, you get angry. Creating a school of computer science wasn't an intellectual vision shared by physicists, the faculty senate and the fine arts people.

JORDAN: Allen Newell really deserves a lot of the credit. Simon preferred to remain on the sidelines. He couldn't care less whether computer science was a department or a school—he was already connected to the rest of the school, so why should he fight?

SIEWIOREK: Allen was a very careful, logical-thinking, great statesman, almost like a Benjamin Franklin. He dropped his research to make the spin-out happen of a School of Computer Science.

MORRIS: Ninety percent of the maneuvering was Allen Newell's doing. Nico was in charge of running the place, but if Allen said we should do something, we did it, and that included Nico.

SIEWIOREK: When Allen talked, people listened. No matter how discouraged you got, when you talked to Allen, you were energized. He was a reluctant administrator. Taking the point position to get us separated was something I'm assuming he felt he had to do, but it would not have been something he aspired to do.

NEWELL (1991): I've never been interested in institutional growth … these were obligations. They were always completely secondary to the science … If you go after institutions, you don't get any science done.

MORRIS: The guy who actually made it happen was Angel Jordan, who was the provost at the time. He put it across over the objections of many people.

JORDAN: I was fairly unpopular at the time. At one point, there was a petition circulated against me among prominent people at Carnegie-Mellon, including some of the trustees.

REDDY: There's another important person at the time, Pat Crecine (IM'61, IA'63, '66), who was a senior vice president. Pat came from the College of Humanities and Social Sciences, but he was strongly computer-oriented.

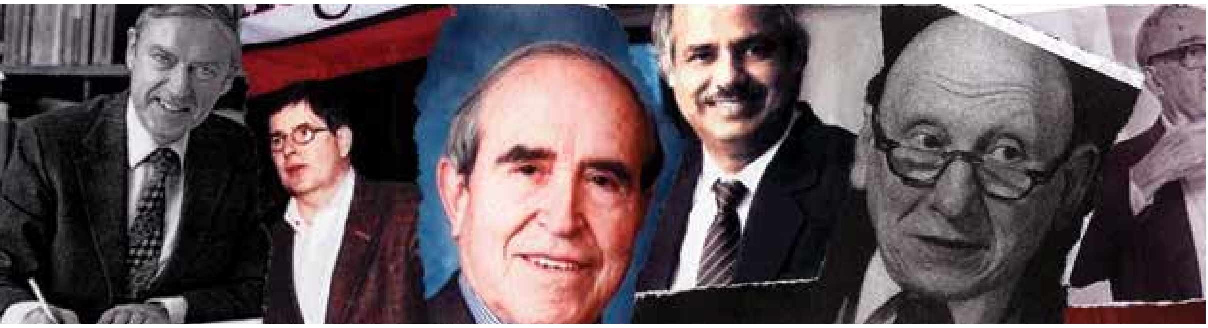
JORDAN: Pat became the champion of the idea of a floating Department of Computer Science, which would report not particularly to one dean or another. Of course, he would also become the supervisor of it! He used the experience very effectively, because when he became president of Georgia Tech, he created the College of Computing, which was more or less a replica of what we were doing at Carnegie-Mellon.

Although unusual, the concept of a free-floating department wasn't entirely without precedent at Carnegie Mellon, which dropped its hyphen in the mid-1980s. Statistics had started as a graduate program unaffiliated with any college before the formation of a Statistics Department within H&SS.

Separately, 1986 saw the creation of the Pittsburgh Supercomputing Center as a joint effort among CMU, the University of Pittsburgh and Westinghouse Electric Corp.

JORDAN: The experiment of the free-floating department was successful. I was happy, Nico was happy, and the rest is history.

REDDY: It took a year or two to decide on the structure of the college. Nico asked, "Do you mind if robotics is part of (SCS), rather than reporting directly to the provost?"



I said, no. So the School of Computer Science became the Department of Computer Science, the Robotics Institute and the Center for Machine Translation.

SCS also incorporated the remaining researchers from the Information Technology Center, which had developed Andrew.

SIEWIOREK: There was some argument about how we should name the school, because there was confusion over the fact there was both a School of Computer Science and a Computer Science Department.

JORDAN: Pat Crecine suggested, "Why not call it the School of Computing?" Some other people said, "Why not the School of Informatics?" Newell resisted that. He said, "It should be called the School of Computer Science."

SCS makes its debut

Although voicing some concerns, CMU's Faculty Senate in the fall of 1988 assented to Cyert's plan to elevate the Department of Computer Science to college status. On Dec. 13, 1988, Cyert told faculty and staff that Habermann had been appointed CMU's first Dean of Computer Science, effective Dec. 1, and that the School of Computer Science would soon begin operations. SCS made its formal debut on Dec. 22, 1988, with a reception in the Wherrett Room of Skibo Hall, CMU's student union. The official announcement of CMU's new "graduate School of Computer Science" was made Jan. 3, 1989.

SCOTT: They should have had an undergraduate program much earlier. At the time the need wasn't so recognized around the country, but it really was essential.

SHAW: There were two things in question—one was the level of university support, and the other one was, "is the field mature enough for an undergraduate program?"

For several years, undergraduates interested in computer science pursued an "applied math/CS" bachelor's degree offered by the Mathematics Department. Shaw led CMU's first effort to design an undergraduate curriculum solely in computer science. She and her colleagues were guided by the Carnegie Plan—guidelines established in 1938 under Carnegie Tech President Robert Doherty (A'40, E'48, H'50), outlining the principles of a sound professional education.

SHAW: The Carnegie Plan says, in substance, that an undergraduate education should include durable education in the ideas of the field. It should teach critical thinking … Yes, it should teach you some of the current skills, but to justify its place in the curriculum, any course needs to have durable intellectual content that will outlast a couple of changes in technology.

The undergraduate program started small, with seven CS majors admitted as sophomores during the 1989-90 academic year. Another 73 undergraduates were admitted in 1990–91. By 1995, there were 401 undergraduates in the School of Computer Science; in fall 2013, more than 600 undergraduates made up about 37 percent of student enrollment at SCS, along with more than 600 master's degree students.

Along the way, the Center for Machine Translation became the Language Technologies Institute, and other new departments formed, including the Human-Computer Interaction Institute (1993), the Institute for Software Research (1999), the Machine Learning Department (2006) and the Ray and Stephanie Lane Center for Computational Biology (2009).

What's next?

TRAUB: CMU is like China, in that when you visit China, if you come back 10 years later, it's an entirely new country, and they have completely reinvented themselves. CMU is the same way. Every time I come back here, I need someone to take me from one place to another, because things have changed so much. But I sometimes ask myself, "Would (SCS) even be here if we had not succeeded back in the 1970s?" Because all it would have taken was one or two more people leaving, and we would have gone sub-critical, and that would have been the end of CMU as a power in computer science.


Herb Simon

SIEWIOREK: I think it would be nice to have some big projects again. Where's the next "Andrew" vision? Where's the next "Wireless Andrew" vision? Maybe things are so diffuse now that it's not possible to come up with something like that to service all of campus. Those big, cohesive projects—there don't seem to be many of them. Red Whittaker (E'75, '79) does some of that with his projects, and ideas such as model checking have certainly attracted a lot of interest. Maybe they're there, and it just takes longer for them to gain public recognition.

REDDY: I've been asking myself, what can we do that's unique and could actually transform the world 10 or 20 years from now? It could be software and algorithms. It may be things such as robotics, and learning, and language. But it's more narrow than all of computer science.

SHAW: We have a couple of challenges. One is to do more research that directly connects with the things people actually do with their computers. HCII runs in that direction. We have people working on usable security, which addresses a particular slice of it. But I don't think we've made much of a dent in the long-standing problem of people being unable to manage their own personal computers. We still have epidemics of infected machines, for instance, that no one has made backups for, and we're not doing a lot to help individuals control their own computing. Electronic medical records are another big opportunity that we are tantalizingly close to being engaged in. One of the big impediments there is data interchange, and heaven knows we've got people who can deal with that.

SCOTT: There are two things that seem important to me: First, the existence of the cloud and having distributed facilities in computing—how to manage them, how to make sure they stay secure and operational—there are a hundred interesting questions there about distributing resources and proper management of information retrieval and programming. Second, how to properly integrate computer resources into teaching is far from being solved. We're not really ready to produce well-designed courses, with people interacting remotely on computers, and integrating those into an academic degree, and it's going to take quite a while to iron that out.

SIEWIOREK: The Pittsburgh Science of Learning Center was way out in front in that field, but then these sort of shallow investigations came along—Massive Open Online Courses—which are getting all of the press. The Simon Initiative is an opportunity for us, because it has two aspects—the deeper science underneath, and a higher-level vision.

REDDY: In the old days, a few people used to know a lot of things. Aristotle in the time of the ancient Greeks, for instance, could read and write when most people were ignorant of those skills. The same thing is happening in computer science. For the first 30 or 40 years, there was a small group of aristocracy in computer science, and we were at the top of the pyramid. When hardware was the king of computer science, we were the place to go. The democratization of computing means that everyone can have that kind of computing today at a fraction of the cost. The question is, what can we do that will still maintain our edge?

—Jason Togyer (DC'96) is editor of The Link and was a contributor to Carnegie Mellon: A Centennial History (2000) by Edwin Fenton (H'66).


Nico Habermann

‘Playing with data’ in physical-type interactions

Kinetica, a new approach for exploring large datasets on touch-screens and other devices, allows users to build a mental model of an information space based on physical interactions

(Editor’s Note: This article is condensed and excerpted from “Kinetica: Naturalistic Multi-touch Data Visualization,” by Jeffrey M. Rzeszotarski (CS’13) and Aniket Kittur of the Human-Computer Interaction Institute. The paper was presented at CHI2014, the Association for Computing Machinery’s CHI Conference on Human Factors in Computing Systems, held in Toronto from April 26 to May 1. To read the original paper, visit jeffrz.com/wp-content/uploads/2014/01/paper1472.pdf. We are grateful to the authors for allowing us to share portions of their research.)

By Jeffrey M. Rzeszotarski (CS’13) and Aniket Kittur
Human-Computer Interaction Institute

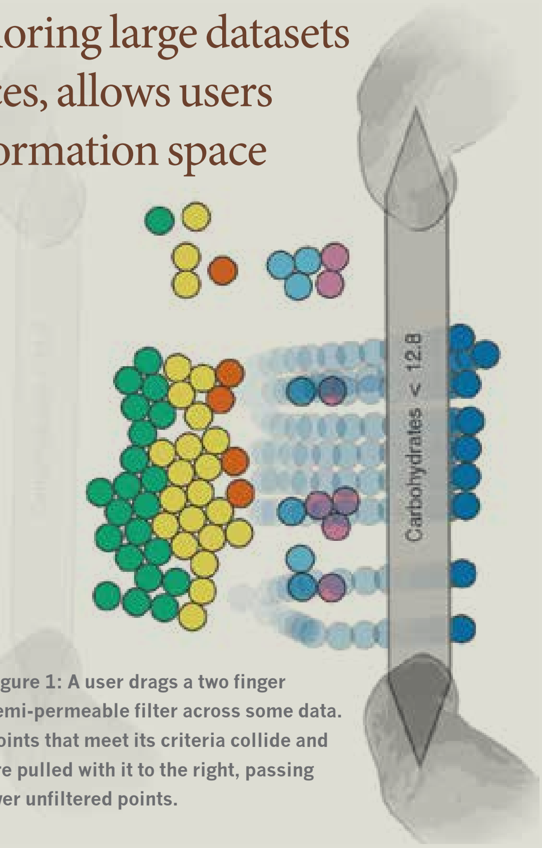


Figure 1: A user drags a two finger semi-permeable filter across some data. Points that meet its criteria collide and are pulled with it to the right, passing over unfiltered points.

From shopping to voting to choosing a new job, the ways in which people consume information and make complex decisions are changing rapidly.

At the same time, a bevy of touch-screen PCs and tablets, collaborative surfaces and interactive whiteboards have hit the market. These devices create an opportunity for developing natural user interfaces—NUIs, for short—that are grounded in naturalistic human ways of interacting with real things.

Yet despite the crucial importance of interpreting and understanding complex data in nearly every personal and business setting, existing techniques for visualizing information have largely failed to make effective use of the direct manipulation techniques enabled by touch-screen devices.

Instead, techniques remain primarily within the realm of traditional, directed interactions using what are sometimes humorously referred to as the “WIMP” elements—windows, icons, menus and pointers—along with spreadsheets, charts and tables.

People are used to taking certain actions in the physical world, and seeing immediate, intuitive results. We throw a stone into a pond, and it creates ripples that flow outward. We use a magnet to attract iron filings. We strain objects through a screen or filter, letting the smallest particles pass through while the larger ones are captured.

What if we could do the same thing in the virtual world—screening our data points, or attracting them like iron filings to a magnet?

If we could get past windows, icons, menus and pointers when users are exploring large sets of data, we might be able to let them build a better mental model of the information space. They might also be able to explore it more fully, and interact more with the data.

By leveraging models from the physical world, users might be able to understand the structure and distributions of data even without significant training or statistical expertise.

In our research, we are exploring how post-"WIMP" interactions might improve exploratory data visualization through the introduction of multi-touch interaction techniques and touch-sensitive simulations that react the way that physical objects react in the real world.

Background

NUIs employ gestures and multi-touch to allow users to interact with on-screen elements. In most cases, NUIs provide intuitive user experiences. But past studies have indicated that NUIs, in some cases, can actually inhibit or constrain users who already know what they want to do.

One highly relevant inspiration for our work is that of Ji Soo Yi, formerly at Georgia Tech, and his colleagues, who developed a system called "Dust & Magnet." Dust & Magnet used the imagery of a magnet and iron filings to allow users to visualize data. It allowed users to place and move virtual magnets that represented certain conditions, attracting and repelling on-screen data points.

"Bumptop," a system created by researchers at the University of Toronto, also provided another example of intuitive, interesting interactions. In Bumptop, files are represented as physical objects that can be pinned to walls and moved around an environment. This has the benefit of requiring minimal training, since people already intuit that unless objects are pinned to walls, they will fall down.

These studies and others suggest that users readily adapt to models that represent data interactions using real-world concepts such as gravity, magnetic attraction or even the build up of sediment to represent the accumulation of data over a period of time.

Developing Kinetica

To explore these types of representations, multi-touch interactions for data visualization, and the technical challenges of implementing such techniques, we developed a proof of concept application called Kinetica. We used an iPad tablet computer because it occupied the physical space of the user; it could be twisted and turned; and it was responsive to touch. To model the forces and collisions, we used MIT's Chipmunk Physics library.

Initially, we encoded data into circles colliding in a sandbox, implemented a touch-responsive magnet tool much like Dust & Magnet, and added gravity based on device orientation. By tilting the device so gravity took hold, and by pulling points with a magnet such that the forces balanced each other, data readily sorted itself and separated, highlighting outliers.

We then loaded different datasets into the program and explored them. We used datasets of cereal and car brands to explore comparisons and decision-making. We used datasets of Titanic shipwreck passengers and Pittsburgh census demographics to see how users might generate and test hypotheses about trends in the data.

As we felt a desire to interact with the data in ways not yet written into the system, we implemented new features. Whenever a feature went unused or was superseded, we

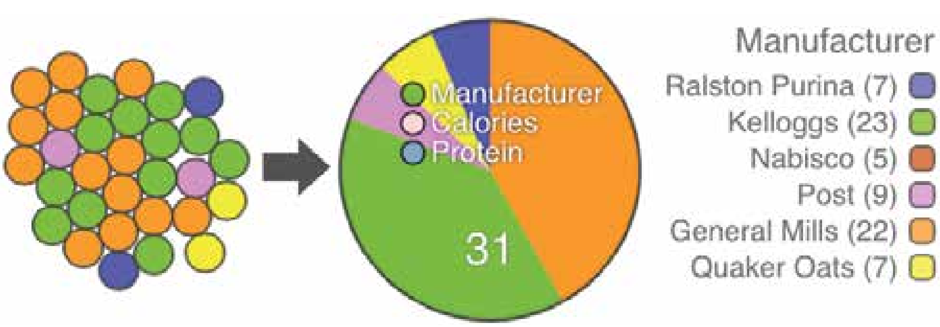


Figure 2: A set of data points can become a group. The pie chart updates dynamically to show distributions.

> For each of the tools we developed, we initially assigned unique gestures and numbers of fingers. For example, to create a barrier, the user would put down four fingers along the contour, while creating a line histogram required only two. This proved cumbersome and confusing.

removed it. Over many successive passes, we designed two primary types of tools: manipulative and interrogative.

Manipulative tools alter locations of data points, or move them around the sandbox. Interrogative tools change the appearance of a point or its interactivity. A mix of these tools can be layered to explore multiple dimensions at once, and the tools leave traces on the sandbox field so users can see what actions are affecting points.

For each of the tools we developed, we initially assigned unique gestures and numbers of fingers. For example, to create a barrier, the user would put down four fingers along the contour, while creating a line histogram required only two. This proved cumbersome and confusing.

Instead, we adopted gestures that used either one or two fingers. Two fingers define two control points, allowing for a histogram between fingers; a bounding box for scatter-plots; a barrier between fingers; a lens spanning fingers; or a group that floats between fingers (to avoid occlusion) that selectively consumes points. One finger gives a user a single control point, which permits drawing freehand histograms; areas to permit or deny points; and lenses; as well as selecting specific points to form a group.

We found that these tools could be combined in interesting ways. A scatterplot that bunched points into categorical clusters could be enhanced with a histogram that pulled points into sorted order. Each cluster still felt a pull towards its group, but also self-assembled into sorted order within the cluster thanks to the influence of the histogram.

Similarly, drawing an area or barrier that rejected a subset of points while a scatterplot was present meant that the filtered points still felt a pull to their proper locations, but were stopped by the barrier. They then took the form of clusters against the barrier. Through techniques like this, we could effectively layer five dimensions of data within our on-screen sandbox.

User testing

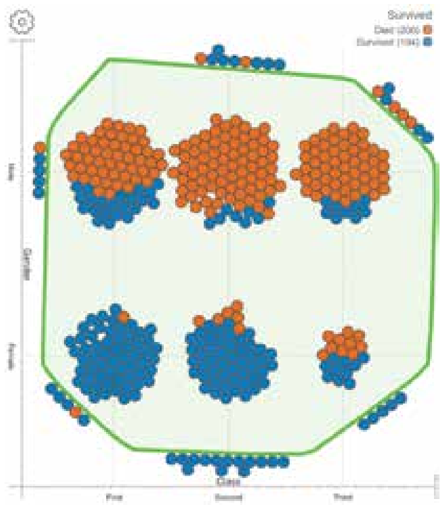
To evaluate Kinetica, we invited participants to use the software for 45 minutes in a lab study. We also invited another group of participants to follow the same study protocol, using Excel rather than Kinetica. Twenty participants reported that they used statistical software such as Excel at least once a month, and all but one reported having used spreadsheets to analyze data at least once. All but two participants had used Excel before.

The study provided five minutes of basic training. Participants using Kinetica followed a built-in tutorial that went over each tool with a use-case example.

After training, participants were asked to look at a dataset of 73 different brands of cereal containing nutritional information. They had 10 minutes to use their respective tools to answer a set of five basic questions of increasing difficulty. These ranged from "What cereal has the most calories?" to "Of cereals with more than 2g of protein and less than 160mg of sodium, which has the most fat?" An observer was available to answer questions about how to use the software, but not give hints about the questions themselves. Participants averaged 3.4 questions correct. There was no significant difference between Kinetica and Excel users.

Following the cereal questions, we asked users to pick a car they would like to buy from a dataset of 133 models with specifications. Purchasing a car often requires people to balance multiple different kinds of data, making this data well suited for multivariate visualizations. We first asked users to write down the criteria they would use for buying a car, to make them to think about different dimensions of the data. Participants reported considering multiple dimensions at once, including cost, horsepower, gas mileage, and car body type. Afterwards, they used either Excel or Kinetica to pore through the data and pick a car they liked. All participants were able to identify at least one car to buy.

In the final 15 minutes, we gave our participants a dataset containing a random sample of 200 passengers on the Titanic. Since they now had experience with the software, we gave them an open-ended prompt. They were to make as many findings as they could in the time limit using the data. We were especially interested in whether the nature of participants' findings would differ by condition. We hypothesized that physics-based affordances would grant participants a more holistic understanding of the data, increasing awareness of trends and distributions and enabling them to layer and investigate multiple dimensions at once.



Results

Kinetica users reported that the tool was easy to learn and made it easy to explore data. Unlike the Excel users, they were likely to describe Kinetica as "fun." Most said they would use it again. They identified the scatterplots and lenses as especially useful, and grouping tools as less useful, perhaps because the grouping tools didn't behave like the force-based tools that comprised most of the interface; the grouping tools absorbed points rather than moving and altering them.

One participant reported that Kinetica was "much better than Excel. I can see when my sort isn't quite right because a point will be where it shouldn't be. It's visual." This points to both the visual memory and process benefits of physics affordances. Other participants identified spontaneous and playful elements, stating Kinetica "allows you to 'play' around with the data," "makes seeing the data fun and interesting," and that its "fluidity made it engaging."

But participants also had some issues using Kinetica. One participant complained that it was hard to get exact numbers for things. While the interface was well suited for qualitative findings, the participant had to tap three times to see numeric details for a point. Interface limitations did not help, as configuration sliders could not always provide enough granularity to participants so that they could set exact filtering criteria they wanted for lenses and barriers. Kinetica also used basic on-screen controls rather than gestures. This meant that they sometimes got in the way, annoying users.

Participants in the Kinetica case generated findings that made use of more dimensions than their peers exploring the same data in Excel. In general, the physics-based tool was more satisfying for participants, and led them to a more holistic understanding of the data they were exploring.

Conclusions

Our initial work in Kinetica points to a fertile new area for exploration in data visualization. Physics-based visualization affordances make use of the inherent expertise users have based on their experiences in the everyday world in order to help them develop an understanding of data.

These techniques are different from traditional visualization approaches, and, in light of users' desire at times for more familiar controls, may work well in concert. Some of the benefits of an approach such as ours include minimal training, better detection of outliers and distributions.

However, because they are different from traditional approaches, it is not always easy or intuitive to create new interactions, and there are limitations, including scalability. In addition, for participants who are experts at using traditional spreadsheet-style tools, an interface such as Kinetica felt constraining.

This work is only one step towards exploring the future of enhanced data interaction. We hope that in the future, researchers from areas such as interface design, human factors and information visualization will generate new and exciting approaches for exploring data that harness the growing tide of new devices available.

As we explored techniques with Kinetica, we developed a framework to generate potential data visualizations. To read about that framework as well as details of our research, please see our full paper, available at http://jeffrz.com/wp-content/uploads/2014/01/paper1472.pdf.

Our initial work in Kinetica points to a fertile new area for exploration in data visualization. Physics-based visualization affordances make use of the inherent expertise users have based on their experiences in the everyday world in order to help them develop an understanding of data.

New dean, new rankings and a look back

By Tina M. Carr

We've packed a lot into these past few months. The big news, of course, is our new dean. Many of you probably know Andrew W. Moore, who joined the SCS faculty in 1993 and has served as a professor of computer science and robotics, working on problems in big data. In 2006, he took a leave of absence to help launch Google's Pittsburgh office.

Now, he's coming home to lead SCS. Andrew plans to be back on campus full time in August.

That means we'll soon be saying a goodbye (of sorts) to SCS's dean for the past 10 years, Randy Bryant, who is stepping down to take a yearlong sabbatical before returning to research and teaching. SCS has grown a lot during Randy's term—physically, scientifically and in the number of programs we offer—and we're grateful for his hard work and dedication. We're planning to honor Randy's service with a celebration June 20 at the Pittsburgh campus … check out www.cs.cmu.edu/june-20 for details as they become available.

We're looking forward to working with Andrew Moore again as well, and seeing where his vision leads us.

Spring Carnival: We greeted about 350 people at the annual SCS/ECE alumni reception during Spring Carnival on April 12, a new record. If you were there, we hope you enjoyed it! If you'd like to be notified about other upcoming events, make sure you're registered with a current email address in CMU's online alumni community (alumni.cmu.edu) or simply send me an email to update your information.

Also during Carnival, many current and former students and faculty gathered to celebrate "JGC60"—the 60th birthday of Jaime Carbonell, Allen Newell Professor of Computer Science and director of CMU's Language Technologies Institute.

Everyone who attended says the symposium was both intellectually stimulating as well as a lot of fun, featuring talks (some of them light-hearted) by many of Jaime's colleagues and former students.

U.S. News Survey: We always know that we're number one in your heart. But our peers have once again ranked our graduate programs in computer science Number 1, according to U.S. News and World Report. The magazine's newest rankings, released a few weeks ago, put CMU's computer science programs in a four-way tie for first place with those of MIT, Stanford and Berkeley.

Along with those three distinguished institutions, we received a perfect 5.0 score.

Randy Bryant cautions that U.S. News' rankings don't use objective criteria, and notes there are questions about their scope. Still, he says, it is a rough measure of what our peers think of the School of Computer Science, and its graduates, and the rankings "continue to show that we are highly regarded in all areas of CS."

You—our alumni, current students and faculty—are a big part of the reason that we're still held in such esteem. Thank you!

What is SCS25? Since our last issue of The Link, I've heard some people express some confusion about "SCS25."

Some people have asked—didn't we already celebrate the 50th anniversary of computer science at Carnegie Mellon? What are celebrating now with SCS25?

Those are legitimate questions. We did celebrate "CS50" back in 2006 with a series of lively and informative events, including some wonderful panel discussions, and many of you participated in those. (The celebration lives online at www.cs50.cs.cmu.edu.)

CS50 marked the beginning of research into computing and computer science at Carnegie Tech in 1956, which we generally date to the arrival of our first computer—an IBM 650.

"SCS25" is about the birthday of the School of Computer Science as an independent college within CMU. Until 1989, the Computer Science Department was under the Mellon College of Science. But as our cover story in this issue notes, by the mid-1980s, we were getting too big to stay a part of MCS.

In some ways, it's sort of an internal celebration, and a way for us to reflect on how far we've come in a relatively short period of time. But we are certainly hoping to share our excitement about the School of Computer Science with a wider audience when we have a big birthday celebration later this year.

(And if you're marking your calendar, 2015 marks a few other anniversaries: The 50th anniversary of the founding of the Computer Science Department and the 25th anniversary of the Master's of Software Engineering Program.)

One idea that we've kicked around is displaying some artifacts from the 1988-89 academic year.

So, were you in the Computer Science Department, the Robotics Institute, the Center for Machine Translation or the Information Technology Center in the late 1980s and early '90s? Do you have anything you can share? Maybe old computer equipment that's gathering dust, or some old photos you'd like to show off? Drop me a note at tcarr@cs.cmu.edu if you'd like to help us celebrate—I'd love to hear what you think.

Tina M. Carr

Tina M. Carr (HNZ'02)
Director of Alumni Relations
tcarr@cs.cmu.edu

Boston-area SCS alumni and their guests got a behind-the-scenes tour of Fenway Park on April 26, then enjoyed dinner at nearby Jillian's restaurant. The event was sponsored by Percipio Media, which was founded by alumnus Fred Goff (TPR'89, HNZ'90).

Andrew Konecki (E'12) and Yisong Wu (CS'13) were among about 350 people who attended our SCS/ECE alumni reception at Spring Carnival on April 12.

Derek L. Beatty (CS'93), Ken Goldberg (CS'88, '90) and James Kuffner, an adjunct associate faculty member in the Robotics Institute, joined the crowd at the Cork & Co. wine bar in Austin, Texas, during a private event for SCS, ECE and Heinz alumni on March 9. The event was timed to coincide with SXSW 2014. Located on Congress Avenue, Cork & Co. is owned and operated by ECE alumnus Kevin Kettler (E'89, '99).

Goksel Dedeoglu

B.S., control and computer engineering, Istanbul Technical University, 1997
M.S., computer science, University of Southern California, 2000
Ph.D., robotics, Carnegie Mellon University, 2007

Digital SLRs capable of shooting Hollywood-quality footage are available for only a few hundred dollars. High-resolution cameras are part of nearly every smartphone. And practically every tablet or notebook computer can stream a movie or TV show.

But although digital video seems to be everywhere these days, Goksel Dedeoglu believes we still have a way to go before computers will be able to watch video and routinely understand it, without human help.

"We have built great multimedia processors for human media consumption, but we haven't quite figured out the right hardware or software for computer vision applications," he says. "When a computer is just trying to extract information (from video), it doesn't necessarily need a full 30 frames per second, and if it's just for algorithmic consumption, it doesn't need to store the video for later, either."

"Computers will eventually be able to autonomously read and interpret video in real-time," Dedeoglu says, "but we have a few fundamental gaps that need to be closed."

Dedeoglu's new company, PercepTonic LLC, is all about closing those gaps. PercepTonic consults with software and hardware companies to help them incorporate computer vision into their products. "Computer vision is all about extracting information from images," says Dedeoglu, "and it's starting to cross the chasm from being an R&D topic to a product feature," in applications such as collision avoidance and self-parking cars.

The improved quality of digital image sensors is one factor making computer vision affordable in consumer applications. Another factor, according to Dedeoglu, is powerful and inexpensive embedded processors. "People have being doing research for years into understanding human facial expressions, for instance," Dedeoglu says. "We now have enough computing power on our portable devices to make using these algorithms a reality."

One of the leading pioneers in computer vision is Takeo Kanade, CMU's U.A. and Helen Whitaker University Professor of Computer Science and Robotics. When Dedeoglu was working on autonomous robots as an undergraduate and master's student, he naturally became interested in computer vision. Going to CMU to work on his doctorate under Kanade "was a no-brainer."

"I learned a lot from Takeo," Dedeoglu says. "Takeo always says, 'Think like an amateur, but execute like an expert.' In other words, let yourself be creative and not limited by what you know is possible, but when it comes to doing something, do it with the best tools and the best algorithms."

It was good advice that served Dedeoglu well during his seven years in the Embedded Vision R&D lab at Texas Instruments. "Some of the popular things people are doing in academia don't map to consumer products," he says. "If you're going to do something, you don't do it for the sake of having a more elegant mathematical model, you do it to solve a real problem and ship a product."

PercepTonic is based in Texas, where Dedeoglu and his wife, Susan Rossbach, make their home. It's also where they're raising their son, who was born in Pittsburgh. "I was a robo-grad (robotics grad student) and she was a member of the RI technical staff, so we used to joke that our son was a robo-baby," Dedeoglu says.

—Jason Togyer (DC'96)

Jason Weill

B.S., computer science, Carnegie Mellon University, 2002

Amazon.com is the world's largest online retailer, but being there can feel a little bit like working for a startup, says software development engineer Jason Weill, who joined the company in May 2006.

Small, "scrappy" teams of five to 10 people, with frugal budgets, do the initial work on new products, and each member of the team performs several different roles. By the time the new feature is ready to make its debut, the team is already working on expanding and enhancing it. "Any good startup is a story of survival, then growth," Weill says.

He knows a bit about startup culture. After his CMU graduation in 2002, he went to work for CombineNet, a Pittsburgh-based company that was developing purchasing software for a wide variety of industries, including retailers, electronic manufacturers and restaurants. When he first interviewed at CombineNet, they were crammed into a small office on South Craig Street, not far from campus. By the time he left in May 2006, the company (which has since been acquired by SciQuest) had 120 employees in three countries.

"We had to work hard, deliver quickly and think big," Weill says.

His first programming experience was with the family's IBM PCjr. Though already outdated when his parents bought it, "it came with about a thousand pages of manuals, and they went everywhere with me," he says. "I must have written hundreds of programs for the PCjr, most of them little experiments to make colorful graphics or annoying noises."

Growing up in the early '90s, he caught both the tail end of the BBS craze and the beginning of the World Wide Web, and the seemingly endless possibilities of the Internet made him even more excited about pursuing a career in computing. "Even before I entered high school, I knew I'd find myself working in some computer-related job," Weill says. His guidance counselor suggested that he apply to CMU.

At SCS, former professor Bruce Maggs, now at Duke, was a big influence on Weill. From Maggs, a co-founder of Akamai, "I gained a lot of knowledge of how computers work, and how to debug software at a low level," Weill says. Outside of the classroom, Weill was involved with a few clubs, notably College Bowl, for which he wrote a software package, Livestat, to track and publish scores.

Weill keeps in touch with many CMU classmates, which isn't hard—he regularly sees them at Amazon.com and other Seattle-area tech companies. CMU's academic network "provides benefits long after graduation," he says.

In his spare time, Weill's hobbies include visiting major league baseball parks around the country, as well as trivia. He's tried, unsuccessfully, to get onto a game show such as "Jeopardy!" Asked for his most obscure trivial fact, he doesn't hesitate: "Vanna White claps 720 times in every episode of Wheel of Fortune according to the Guinness Book of World Records, which I read religiously before there was Wikipedia. I've stunned a room on two different occasions by reciting that fact."

—Jason Togyer (DC'96)

$10M YAHOO GRANT PAVES WAY FOR UNPRECEDENTED COLLABORATION

Tom Mitchell

Ron Brachman, chief scientist and head of Yahoo Labs

A new partnership between CMU and Yahoo Labs will give students and faculty unprecedented access to live data in order to improve the company's mobile applications.

The company has made a five-year, $10 million grant to Carnegie Mellon for the launch of "Project InMind," an effort to bring the latest machine-learning techniques to bear on Yahoo's mail and news apps.

Tom Mitchell, Fredkin University Professor and head of the Machine Learning Department, and Justine Cassell, Charles M. Geschke Director of the Human-Computer Interaction Institute, will lead the effort for CMU.

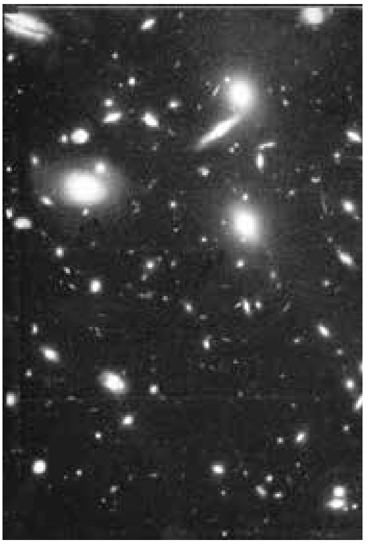
Researchers said that Project InMind is looking for ways that contextual clues can enhance user experiences with Yahoo's applications. Those clues might come from the kinds of Web searches users conduct, the links they click and the content of their messages. Users will have to "opt-in" before their data can be shared, and other privacy protections also will be in place.

Besides being able to work with real-time data—something to which researchers rarely have access—the partnership also will include new Yahoo-sponsored fellowships for computer science students and faculty members.

CMU has established itself as a "premier institution for machine learning and human-computer interaction research, and these are the main focal areas of our partnership," said Ron Brachman, chief scientist and head of Yahoo Labs. "We like to think of this as a grand-scale living laboratory where researchers can explore new approaches to understanding human behavior through machine learning and interface technologies."

Yahoo has declined to say exactly what kind of products might emerge from research conducted as part of Project InMind—Brachman told CNet the company doesn't have an "articulated vision for that yet"—but the partnership with CMU has already led to excited speculation among technology journalists and bloggers.

MACHINE LEARNING TRANSFORMS COSMOLOGY'S 'SCIENCE BY EYE'



Like other scientists, astrophysicists first used computers as glorified calculators. But in the era of "big data," statistics and machine learning are becoming increasingly important in order to understand and interpret cosmological information.

Jeff Schneider, a CMU research professor of computer science, will lead a three-year, $1.6 million project funded by the U.S. Department of Energy to sift through enormous data sets, comparing computer simulations with observations to search for areas where theory and reality don't match up.

"Astrophysicists can no longer do 'science by eye,'" said Schneider, who will be joined by collaborators in physics, machine learning and statistics. "There are just too many variables."

ASTROBOTIC: ONE SMALL STEP CLOSER TO LANDING ON THE MOON

CMU-spinoff Astrobotic Technology has successfully tested the landing guidance system it will use to place a robot on the moon.

The company tested the Astrobotic Autolanding System, or AAS, in February in California's Mojave Desert with assistance from the NASA Flight Opportunities Program. Working in partnership with CMU, Astrobotic is competing with other teams for the $20 million Google Lunar XPrize in a bid to become the first private organization to land a rover on the moon.

Video of the test is available on YouTube at www.bit.ly/AASvideo.

AAS uses visual navigation to provide precise, real-time location updates for Astrobotic's lunar landing craft, Griffin. Its two cameras work together like a pair of human eyes to measure distance and track motion.

SCS TEAMS WIN STARTUP CASH IN McGINNIS COMPETITION

Three teams that included School of Computer Science students and alumni took prizes in the 2014 McGinnis Venture Competition, a cross-campus entrepreneurial challenge.

The competition is sponsored by the Carnegie Mellon Center for Innovation and Entrepreneurship, which includes SCS's Project Olympus as well as the Tepper School of Business's Donald H. Jones Center for Entrepreneurship.

In the McGinnis competition, students compete for $60,000 in investments for their startup companies. Grad students Justin Betteridge (CS'06) and Medhi Samadi won an investment of $15,000 for their startup company, Solvvy Inc., which has created an intelligent problem-solving assistant, while grad student Anuj Kumar (CS'12) was part of a team that attracted $10,000 for its database company, Appbase.

First prize among undergraduates ($4,000) was secured by a six-person team representing three schools, including SCS. Their startup, named Tailored Fit, is an online shopping service.

Bugfix

Due to my own error, a photo on page 3 of the Fall 2013 issue of The Link used an incorrect caption that misidentified the people depicted. They are associate professor Lorrie Cranor, associate professor Noah Smith and professor Norman Sadeh. My apologies to Noah Smith and assistant professor Travis Breaux.

—Jason Togyer (DC'96)

POST-DOC PREDICTS THE RISE AND FALL OF ONLINE COMMUNITIES

Bruno Ribeiro

A wise man once said, "Today's peacock is tomorrow's old feather-duster." The popularity of online communities can be short-lived, too. Facebook, now celebrating its 10th anniversary, is a proven success, but when might it reach its peak? And when will other online communities begin to wither?

Bruno Ribeiro, a post-doctoral researcher in the Computer Science Department, has developed a new model to assess the viability of websites and social networks and predict which ones will be sustainable, and which ones won't.

Ribeiro says he was inspired by the work of the late Nobel laureate Herb Simon, one of the founders of CMU's computer science programs, who observed that too much content can be as bad for an information ecosystem as too little—that a "wealth of information creates a poverty of attention."

His paper was presented in April at the World Wide Web Conference in Seoul. You can read more at www.bit.ly/riberio-study.

HCII'S CASSELL TAKES ADDITIONAL ROLE IN LEARNING TECHNOLOGY OUTREACH

Justine Cassell

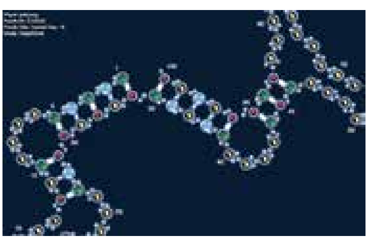
Justine Cassell has taken on new additional responsibilities as the university's associate vice provost of technology strategy and impact. She also is serving as co-director of The Simon Initiative.

As a result of her added new responsibilities, Cassell has announced plans to step down as the Charles M. Geschke Director of the Human-Computer Interaction Institute. A search has begun for her replacement.

Provost Mark Kamlet says Cassell's duties as associate vice provost include strategy and outreach efforts related to the Global Learning Council, as well as university-wide efforts that fall broadly within the area of human-computer interaction.

The Global Learning Council, chaired by President Subra Suresh, is a component of The Simon Initiative. The GLC is a distinguished group of thought leaders from across the globe who are committed to the use of science and technology to enhance learning.

IN RNA DESIGN, HUMAN INGENUITY BEATS COMPUTER ALGORITHMS



Players of the EteRNA game have produced designs for RNA molecules that are consistently more successful than those generated by the best computer algorithms, according to researchers from CMU and Stanford.

What's more, those researchers were able to use some of the best design rules and practices generated by those EteRNA players to create a new algorithm that also was better than the best prior computer algorithms. But even that still wasn't as good as the designs generated by the 130,000-member EteRNA community.

SCS's Adrien Treuille, who leads the project along with Stanford's Rhiju Das and CMU Ph.D. student Jeehyung Lee, calls the results "amazing and far beyond what any of us anticipated."

The team published its results last month in the online Early Edition of the Proceedings of the National Academy of Sciences.

POLITICO: SCS AND CMU PLAYED KEY ROLES IN PITTSBURGH'S REBIRTH

Thirty years ago, as the U.S. steel industry faced drastic job cuts, Pittsburgh appeared to be on the brink of disaster. Today, it's celebrated as a paragon of cities that have been able to reinvent themselves.

"The Robots That Saved Pittsburgh," an article in the February issue of Politico magazine, said the School of Computer Science played a key role in saving the Steel City from the fate of other post-industrial metropolitan areas in the "Rust Belt."

Writer Glenn Thrush talked to many CMU faculty members, including the Robotics Institute's Red Whittaker (E'75,'79), and also cites the contributions of Luis von Ahn (CS'03,'05), Raj Reddy, Sanjiv Singh (CS'91,'95), Angel Jordan and Manuel, Avrim and Lenore Blum as important players.

CMU's intellectual firepower has been vital in making Pittsburgh attractive to companies such as Apple, Disney, Google and the RAND Corporation, Thrush argued, "and robots are just the most visible piece of this miraculous turnaround of a city on the brink."

LANE RESEARCHER'S COMPUTER MODEL IDENTIFIES NEW SUBTYPES OF ASTHMA

If you or someone you love is living with asthma, you know that a lot of different variables can trigger an asthma attack. But a computer program, designed by a CMU researcher, has tracked more than 100 variables for 400 people and identified various subtypes of asthma.

That, in turn, could lead to more targeted—and more effective—treatments for asthma sufferers.

Wei Wu, an associate research professor in the Lane Center for Computational Biology, led the analysis of patient data from the federally funded Severe Asthma Research Program. She says many of the types of asthma identified by computer methods are consistent with subtypes already recognized by clinicians—types related to allergies, sinus disease and environmental factors.

But the analysis also identified clusters of patients that suggest new subtypes, including one in which frequent, severe asthma symptoms may be associated with poor quality of life, depression and obesity.

SNAKEBOTS ARE SLIDING INTO EUROPEAN OPERATING ROOMS

The snake-like flexible robots developed by CMU's Howie Choset (see Fall 2013 issue) are about to take their place in hospital operating rooms.

Medrobotics Corp., a CMU spinoff, has received approval to begin limited marketing in Europe of a robotic surgical device based on the research of Choset, a professor of robotics. The Flex System will enable surgeons to see and operate in hard-to-reach anatomical locations during head and neck surgery.

Pittsburgh was the ideal starting point for the technology, Choset said, because of the world-class robotics expertise of Carnegie Mellon and the world-class medical research of the University of Pittsburgh.

Choset, a leading expert on multijointed robots that resemble snakes, has developed a series of robots capable of making their way through the rubble of collapsed buildings, climbing poles and crawling through pipes.

PERU-TO-THAILAND POLAR VORTEX BRINGS TEAM A TOP DISNEY PRIZE

A team of CMU undergrads imagined a two-week cultural exchange where visitors were figuratively transported between Thailand and Peru—opposite sides of the globe.

Their project, called "Antipode," took first place in the annual Walt Disney Imagineering "Imaginations" competition in Glendale, Calif., which helps the entertainment company seek out and nurture future interns and possible employees.

Teams were told to select a large, densely populated city and design an experience that temporarily or permanently transformed the city for the enjoyment of its residents and visitors.

The CMU team, which included Matthew Ho and Christina Brant, both fifth-year seniors in architecture, John Brieger, a senior in computer science, and Angeline Chen, a junior majoring in communication design, developed a backstory in which two children discovered a magical portal between Bangkok and Lima.

CS'S DANNENBERG CONDUCTS 100 DIGITAL MUSICIANS IN GLOBAL ORCHESTRA

Conducting an orchestra presents a challenge—especially when the musicians are scattered around the globe and using laptop computers as instruments.

Roger Dannenberg

Roger Dannenberg (CS'03), an alumnus and professor of computer science, music and art, set out to accomplish this feat March 1, when he directed 100 people worldwide in an unprecedented concert performance.

Dannenberg led the Global Network Orchestra from Connecticut College during the Ammerman Center's 14th Biennial Arts and Technology Symposium.

The musicians used keystrokes to create the sounds. The keystroke signals, which require far less bandwidth than streaming audio, were shared across the entire orchestra, enabling each musician to simultaneously create the concert in their own laptops. They played along using scrolling graphical scores.

Dannenberg also included improvisation and split the orchestra into four groups at some points.

SCS ALUMNA BECOMES YOUNGEST IBM'ER TO REACH PATENT MILESTONE

Lisa Seacat DeLuca (CS'05) is an inventor on fire. The IBM mobile software engineer has filed 350 patent applications with the U.S. Patent and Trademark office—and 115 already have been issued.

With that, DeLuca has become the youngest IBM employee ever to reach the 100-patent milestone at IBM, and the first woman honored for that achievement. Network World calls her one of the 50 most fascinating people in the world of technology.

"I am super proud to have attended Carnegie Mellon University, and I am quick to tell anyone who'll listen about my experience there," DeLuca says. She's one of nearly 600 CMU alumni working for IBM and its affiliates.

Lisa Seacat DeLuca

NOTABLE NAMES

The Guatemalan government bestowed its highest honor, the National Order of the Sovereign Congress, on native **Luis von Ahn** (CS '03,'05), associate professor of computer science, for his research and business career.

Kumar Avinava Dubey, a Ph.D. student in the Machine Learning Department, has been awarded an IBM Ph.D. Fellowship Award for the 2014-15 academic year.

Aarti Singh, assistant professor of machine learning, is one of 42 scientists selected this year to receive research funding for three years through the Air Force's Young Investigator Research Program.

CLOUDS, an interactive documentary developed with significant support from the Center for Computational Thinking and the Computer Science Department, had its Pittsburgh premiere March 20 in the Frank-Ratchye STUDIO for Creative Inquiry.

Former SCS associate professor **Mark Raibert**, chief technology officer and director of Boston Dynamics, delivered a lecture April 10 at CMU as part of the campus' National Robotics Week celebrations.

Jennifer Mankoff, associate professor of HCII, has conducted the largest-ever survey of patients with Lyme disease in a joint effort with LymeDisease.org. The study, which included more than 3,000 patients, was published in the online journal PeerJ.

Time magazine employed the **GigaPan** technology developed by CMU's CREATE Lab and NASA to produce a breathtaking panorama from New York City's new One World Trade Center. You can see it at www.bit.ly/CMU-1WTC.

Will Crichton, a sophomore computer science major who is considering a double major in Chinese studies, won first prize in the fifth-annual "Chinese Bridge" Eastern USA Competition March 30.

With the addition of a charger for Tesla vehicles, **CMU's Electric Garage**, a project of the CREATE Lab, is now one of the largest electric-car charging stations in Pennsylvania.

Mark Stehlik, former SCS assistant dean for undergraduate education who currently serves as associate dean for education at Carnegie Mellon Qatar, was invited to give a TEDx talk at Education City in Doha.

Aarti Singh and **Siddhartha Srinivasa** (CS'01,'05) have been named to CMU Finmeccanica Chairs in Computer Science. These endowed chairs are reserved for faculty members who show exceptional promise in the early stages of their careers.

Jodi Forlizzi (A'97, CS'07), associate professor of human-computer interaction and design, has been named to the CHI Academy—an honorary group of individuals who have made substantial contributions to the HCI field.

Peter Chapman, a Ph.D. student in computer science, was one of the students featured as part of a segment on PBS's NewsHour about "good-guy hackers."

Andy Warhol's Amiga

Left: Commodore Amiga computer equipment used by Andy Warhol.

Below: Artist Cory Arcangel (center) and CMU Computer Club members Michael Dille (CS'06,'07,'10,'13) and Keith Bare (CS'08,'09) during the data recovery process. Both photos courtesy The Andy Warhol Museum.

It's a problem that's increasingly more common—how do we recover old files saved in obsolete formats? Tucked away on old tapes or diskettes that can't easily be read by new machines, some files seem to be gone forever.

Andy Warhol (A'49) was always slightly ahead of his time, so it's no surprise that his digital artwork is among the oldest to have been presumed lost in that way—at least until Golan Levin, CMU associate professor of art, and the Carnegie Mellon Computer Club stepped in.

Working with curators at Pittsburgh's Andy Warhol Museum, they recovered 28 digital images created by Warhol, several of which depict iconic Warhol subjects such as celebrities and those ubiquitous Campbell's Soup cans.

In 1985, Warhol was asked by computer company Commodore International to create art using their then-new Amiga 1000. One published work resulted from the collaboration—a portrait of rocker Debbie Harry, now in the collection of the Warhol Museum.

Warhol's Amiga doodles were saved on floppy disks, also in the museum's collection, but no one knew how to access the files. Warhol died in 1987 and although the Amiga still has a passionate fanbase, Commodore itself has been defunct since 1994.

In November 2011, artist Cory Arcangel, a fan of Warhol's, found out about Warhol's Amiga experiments from a video on YouTube. He and Tina Kukielski, a curator at the Carnegie Museum of Art, asked for help reading the diskettes from Levin, director of the Frank-Ratchye STUDIO for Creative Inquiry, and the Computer Club. By February 2013, the Computer Club and the Warhol archivists were able to recover the data, and when no available software would open the documents, they reverse-engineered the files.

The team's efforts were documented for a short film, "Trapped: Andy Warhol's Amiga Experiments," which debuted May 10 in Pittsburgh.

"What's amazing is that by looking at these images, we can see how quickly Warhol seemed to intuit the essence of what it meant to express oneself, in what then was a brand-new medium: the digital," Arcangel says.

You can read more at the STUDIO's website, www.studioforcreativeinquiry.org. "Trapped" can be viewed at www.nowseethis.org.

—Jason Togyer (DC'96)

calendar of events

All events to be held on the Carnegie Mellon University campus in Pittsburgh, unless otherwise noted. Dates and locations subject to change without notice. Visit calendar.cs.cmu.edu for a complete and current listing of events.

June 5
Launch|CMU
Research and technology startup showcase
Silicon Valley

June 6–8
Carnegie Mellon Alumni Volunteer Forum

June 14
Carnegie Mellon Alumni Picnic
Central Park, New York City

June 17
Carnegie Mellon Alumni Career Webinar:
"How to make better decisions in life and work"

June 25
SCS/ECE Alumni Reception
Washington, D.C.

June 28
SCS/ECE Boston Alumni Luncheon
Museum of Science, Boston

June 29–July 25
Summer College Preview Program
Carnegie Mellon Qatar
Doha, Qatar

July 12
SCS/ECE San Francisco Bay Area Alumni Reception

July 19
SCS/ECE Seattle Alumni Cruise

July 20
20th Annual Carnegie Mellon Alumni Boston Clambake

Aug. 11–14
Graduate Student Orientation

Aug. 17–24
First-Year Student Orientation

Aug. 25
Fall semester begins

Sept. 1
Labor Day: No classes; university closed

Sept. 8
Fall semester add-drop deadline

Oct. 9–12
Cèilidh: Homecoming and Family Weekend

Oct. 17
Mid-semester break: No classes

Nov. 25
Andrew Carnegie born, Dunfermline, Scotland, 1835

Nov. 26–28
Thanksgiving holiday: No classes; university closed
Nov. 27–28

Dec. 8
Final exams begin

Dec. 16
Residence halls close for winter break

Dec. 18
Final grades due

Dec. 24–25
University closed

Dec. 31, 2014–Jan. 1, 2015
University closed

Jan. 7, 2015
Residence halls reopen

Jan. 12
Spring semester begins

Jan. 19
Martin Luther King Jr. Day observed,
no classes after 12:30 p.m.

Carnegie Mellon University
School of Computer Science

Office of the Dean
5000 Forbes Avenue
Pittsburgh, PA 15213

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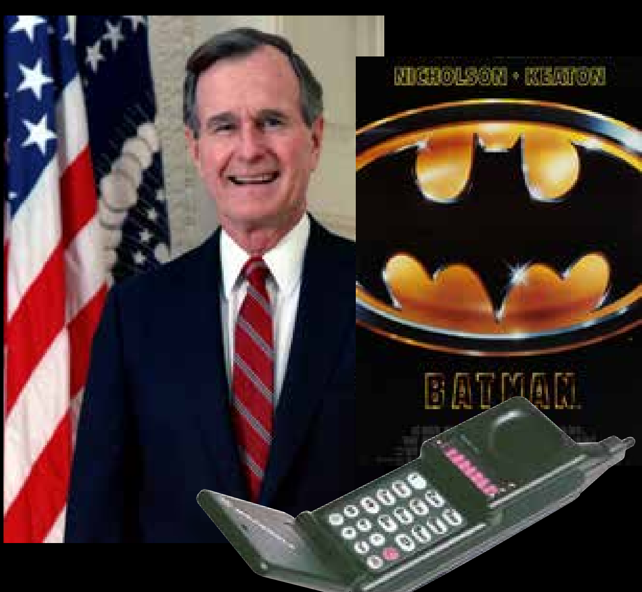

A memorable year

Lots of memorable things were happening in 1989. Motorola was introducing its first flip-phone. George H.W. Bush was president of the United States.

And Pittsburgh's Michael Keaton was Batman.

Something special also was happening at Carnegie Mellon University in 1989 ... the creation of the School of Computer Science.

Over the past 25 years, our faculty and alumni have made their marks on the world. They've pioneered advances in mobile technology. They've helped world leaders make decisions about computer security. And they've improved the graphics in summer blockbusters.

Thank you for being a part of our first 25 years. We look forward to celebrating our silver anniversary with you this fall!

SCS25
25TH ANNIVERSARY 2014

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Carnegie Mellon University