

# Conduit

An aerial photograph of a landscape, likely a valley or a coastal area, showing a mix of green fields, brownish terrain, and some buildings. The sky is a clear, deep blue. Overlaid on the image are several white, curved lines that sweep across the frame from the top right towards the bottom left, creating a sense of movement and depth.

A RESEARCH AND ALUMNI NEWS MAGAZINE

Department of Computer Science, Brown University // Vol. 21 No. 2

## Dropbox in Space

- + Computer Program can Identify Rough Sketches
- + Brown Awarded \$1.5M for new Big Data tools
- + Transactional Memory: An Idea Ahead of its Time

# Notes from the Chair: the Latest News from 115 Waterman

Greetings to all CS alums, supporters and friends.



With this fall issue of *Conduit*, I offer my sincerest congratulations to all the undergraduate and graduate students who received their degrees at commencement last May. It was a pleasure having all of you as part of the CS “family,” and I hope that you will keep us informed of your life trajectories and return to visit the department when you are in the Providence area.

Congratulations are in order for Ugur Çetintemel and Shriram Krishnamurthi who were promoted to Professor, effective July 1, 2012.

- Ugur is the recipient of an NSF CAREER award and was a Brown University Manning Assistant Professor. His research has been funded by NSF, the Army Medical Research and Material Command, and several corporations. He is a co-founder and a Technical Advisory Board member for StreamBase Inc., a high-performance analytics company. His research interests include database systems, distributed systems, and mobile and ubiquitous computing.
- Shriram has received ACM SIGPLAN’s Robin Milner Young Researcher Award, an NSF CAREER award and Brown’s Henry Merritt Wriston Fellowship for excellence in teaching. He has obtained research funding from NSF and several corporations and foundations. His research interests include computer-aided verification, computer security, programming languages, and software engineering.

In addition, Barbara Meier (’83, Sc.M. ’87) has been promoted to Senior Lecturer. Barb teaches computer animation. She focuses on aesthetics and storytelling as much as technical aspects in her courses, which include Introduction to Animation and Intermediate Computer Animation. Congratulations, Barb!

The department is pleased to announce several additions:

- Michael Littman, PhD ’96, returned to Brown this Fall with a Professor appointment. He previously spent many years at Rutgers as the director of the Laboratory for Real-Life Reinforcement Learning and as chair of the Computer Science Department

from 2009 until June 2012. Michael is a Fellow of the Association for the Advancement of Artificial Intelligence. His research interests include reinforcement learning, human-computer interaction, planning, and complexity theory.

- Tim Kraska will come to Brown as an Assistant Professor in January after serving as a postdoctoral scholar at the University of California at Berkeley, working in the AMP Lab on big-data management and hybrid human/machine database systems.
- Paul Valiant joined the faculty as Assistant Professor in September. He was previously a postdoctoral scholar at the University of California at Berkeley in the Theory of Computation group. He received his PhD from MIT and his interests include cryptographic and algorithmic game theory and coding theory.

I am also excited to report that enrollment in our introductory classes continues to rise. Total enrollments for both undergraduate and graduate students have grown 10% since last year. Especially impressive is that the number of students taking our introductory courses has grown by 54% since 2010.

It is with mixed feelings that I announce the departure of Pascal Van Hentenryck, who is now professor of computing and information systems at the University of Melbourne in Australia and the leader of the Optimization Research Group at NICTA (National Information and Communications Technology Australia). The department and the university greatly benefited from Pascal’s outstanding research and educational contributions for over two decades. We will miss his presence in the department and we wish him continued success in his new endeavors. Number 31 will be retired as a course number in Pascal’s honor.

Finally, we urge you to contribute your research and personal stories for inclusion in upcoming issues of the *Conduit*. Your support of and participation in department activities is much appreciated and we are thankful to have such a close community — thank you!

Roberto Tamassia  
*Plastech Professor of Computer Science  
Chair, Department of Computer Science*

# Conduit

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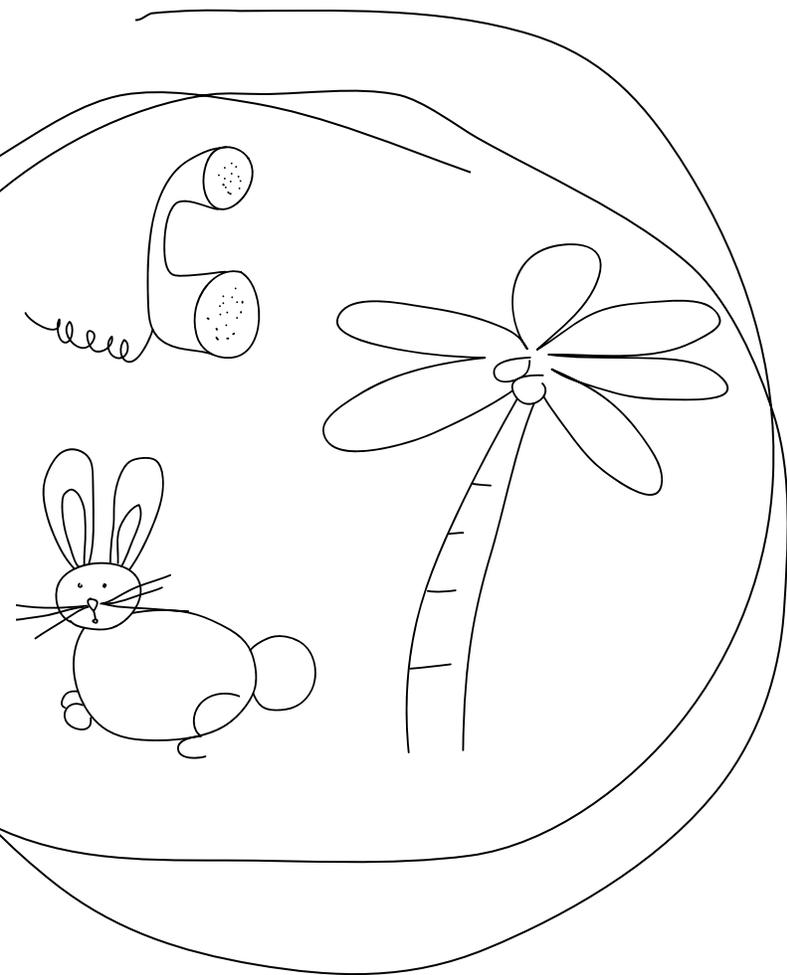
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# Computer program identify rough sketc

BY KEVIN STACEY, BROWN PAUR

Ears and whiskers are a hint... Computers can recognize photos and careful drawings of rabbits, but quick sketches by non-artists... not so much. Researchers in Providence and Berlin say they have produced the first computer application that enables “semantic understanding” of abstract sketches.



Computers are good at speed, numbers, and massive amounts of data, but understanding the content of a simple drawing is more difficult. Researchers at Brown and the Technical University of Berlin have produced a computer application that can identify simple abstract sketches of objects almost as often (56 percent of the time) as human viewers (73 percent).

First they took over chess. Then Jeopardy. Soon, computers could make the ideal partner in a game of Draw Something (or its forebear, Pictionary).

Researchers from Brown University and the Technical University of Berlin have developed a computer program that can recognize sketches as they're drawn in real time. It's the first computer application that enables “semantic understanding” of abstract sketches, the researchers say. The advance could clear the way for vastly improved sketch-based interface and search applications. The research behind the program was presented last month at SIGGRAPH, the world's premier computer graphics conference. The paper is now available online, together with a video, a library of sample sketches, and other materials.

Computers are already pretty good at matching sketches to objects as long as the sketches are accurate representations. For example, applications have been developed that can match police sketches to actual faces in mug shots. But iconic or abstract sketches — the kind that most people are able to easily produce — are another matter entirely.

For example, if you were asked to sketch a rabbit, you might draw a cartoony-looking thing with big ears, buckteeth, and a cotton tail. Another person probably wouldn't have much trouble recognizing your funny bunny as a rabbit — despite the fact that it doesn't look all that much like a real rabbit.

# can hes

“It might be that we only recognize it as a rabbit because we all grew up that way,” said James Hays, assistant professor of computer science at Brown, who developed the new program with Mathias Eitz and Marc Alexa from the Technical University in Berlin. “Whoever got the ball rolling on caricaturing rabbits like that, that’s just how we all draw them now.”

Getting a computer to understand what we’ve come to understand through years of cartoons and coloring books is a monumentally difficult task. The key to making this new program work, Hays says, is a large database of sketches that could be used to teach a computer how humans sketch objects. “This is really the first time anybody has examined a large database of actual sketches,” Hays said.

To put the database together, the researchers first came up with a list of everyday objects that people might be inclined to sketch. “We looked at an existing computer vision dataset called LabelMe, which has a lot of annotated photographs,” Hays

## “THE GAP BETWEEN HUMAN AND COMPUTATIONAL PERFORMANCE IS NOT SO BIG, NOT AS BIG CERTAINLY AS IT IS IN OTHER COMPUTER VISION PROBLEMS”

said. “We looked at the label frequency and we got the most popular objects in photographs. Then we added other things of interest that we thought might occur in sketches, like rainbows for example.”

They ended up with a set of 250 object categories. Then the researchers used Mechanical Turk, a crowdsourcing marketplace run by Amazon, to hire people to sketch objects from each category — 20,000 sketches in all. Those data were then fed into existing recognition and machine learning algorithms to teach the program which sketches belong to which categories. From there, the team developed an interface where users input new sketches, and the computer tries to identify them in real time, as quickly as the user draws them.

As it is now, the program successfully identifies sketches with around 56-percent accuracy, as long as the object is included in one

of the 250 categories. That’s not bad, considering that when the researchers asked actual humans to identify sketches in the database, they managed about 73-percent accuracy. “The gap between human and computational performance is not so big, not as big certainly as it is in other computer vision problems,” Hays said.

The program isn’t ready to rule Pictionary just yet, mainly because of its limited 250-category vocabulary. But expanding it to include more categories is a possibility, Hays says. One way to do that might be to turn the program into a game and collect the data that players input. The team has already made a free iPhone/iPad app that could be gamified.

“The game could ask you to sketch something and if another person is able to successfully recognize it, then we can say that must have been a decent enough sketch,” he said. “You could collect all sorts of training data that way.”

And that kind of crowdsourced data has been key to the project so far.

“It was the data gathering that had been holding this back, not the digital representation or the machine learning; those have been around for a decade,” Hays said. “There’s just no way to learn to recognize say, sketches of lions, based on just a clever algorithm. The algorithm really needs to see close to 100 instances of how people draw lions, and then it becomes possible to tell lions from potted plants.”

Ultimately a program like this one could end up being much more than just fun and games. It could be used to develop better sketch-based interface and search applications. Despite the ubiquity of touch screens, sketch-based search still isn’t widely used, but that’s probably because it simply hasn’t worked very well, Hays says.

A better sketch-based interface might improve computer accessibility. “Directly searching for some visual shape is probably easier in some domains,” Hays said. “It avoids all language issues; that’s certainly one thing.”

# Brown awarded \$1.5M for new Big Data tools



BY KEVIN STACEY, BROWN PAUR

**As datasets expand and new generations of faster computers arrive, users urgently require more powerful algorithms to make sense of Big Data.**

Brown computer scientists have received a \$1.5-million award from the National Science Foundation and the National Institutes of Health to conduct research on new analytical tools for Big Data.

Computer scientists from Brown University have been awarded \$1.5 million to develop new computer algorithms and statistical methods to analyze large, complex datasets. Funding for the project comes from a joint initiative of the National Science Foundation and the National Institutes of Health aimed at supporting fundamental research on Big Data.

Eli Upfal, professor of computer science, will lead the research with fellow computer science professors Ben Raphael and Fabio Vandin. Brown's funding allotment is the second largest of the eight grants awarded under the program this year, according to the official NSF/NIH announcement.

Upfal and his colleagues will test their new methods on genomics data. Nowhere are the challenges of Big Data more evident than in genomics. As techniques for sequencing genes have become faster and cheaper, researchers have compiled mountains of new data. The trick now is trying to make sense of it all — picking out significant trends and ignoring all the unimportant “noise” that inevitably accumulates in large datasets.

“These datasets have all the good and bad properties of Big Data,” Upfal said. “They’re big, noisy, and require very complicated statistical analysis to obtain useful information.”

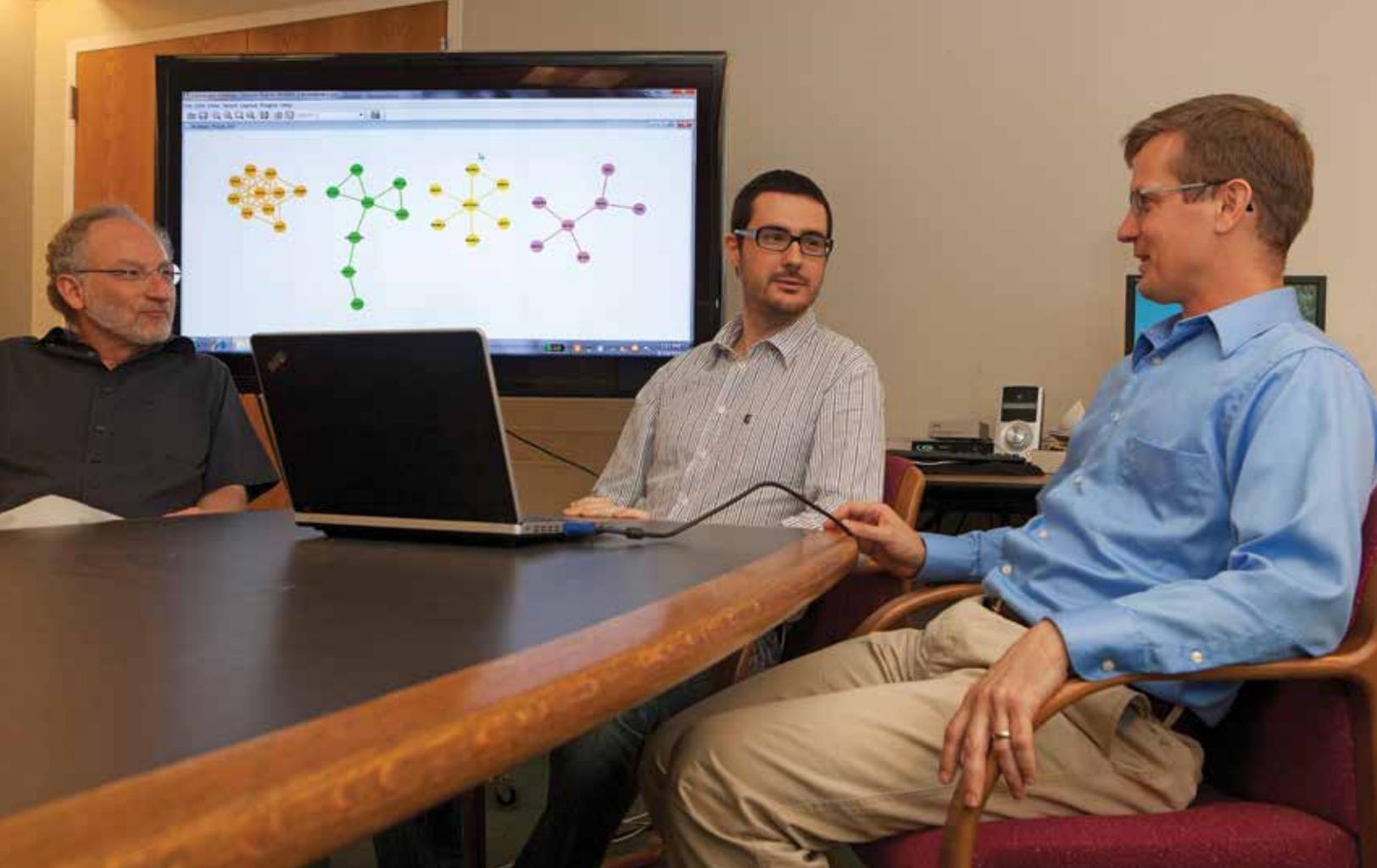


Photo Credit: Mike Cohea

One of the aims of this project is to develop better computational tools to isolate genetic mutations that drive cancer by comparing gene sequences of healthy tissue to those of cancerous tissue. The problem is that not every mutation found in cancerous cells is important. There could be thousands of mutations in each cell that don't actually contribute to cancer growth. They're simply insignificant, random mutations. An effective computer algorithm will be able to identify with statistical certainty the mutations that actually matter, keeping doctors from chasing millions of red herrings.

But that's not the only problem Upfal and his team will try to address. There's also the fact that the lab tools used to sequence genes sometimes record information inaccurately. The error rate varies between sequencing techniques but it's significant, and analytical tools need to deal with that problem as well.

One of the thrusts of the Brown project is finding algorithms that address these problems in a way that can be verified statistically. The output of traditional machine learning algorithms, Upfal said, is generally not confirmed in an objective way. Take search engines as an example. If the search algorithm consistently returns the kinds of

results users are looking for, they'll keep using it and the algorithm will be deemed successful. But that evaluation is subjective and largely unquantifiable.

"In scientific applications, you need something that can be analyzed rigorously," Upfal said. "We need to know the confidence level of the outcome." So a key aspect of this project will be combining traditional machine learning algorithms with the most rigorous of statistical methods.

Daunting as the obstacles may be, Upfal and his colleagues have already had success in addressing them. Last year they developed an algorithm called HotNet that helps to isolate clusters of mutated genes that can cause cancer. They're hoping to build on that success with this new grant.

Ultimately, Upfal said, the team hopes to develop new tools that can be broadly applied not only to genomics data but also to other Big Data problems like the analysis of large-scale social networks.



“WE ALWAYS SAID THAT PARALLEL MACHINES WITH MORE THAN ONE PROCESSOR WERE GOING TO BE IMPORTANT SOMEDAY, **BUT NOBODY KNEW WHEN IT WOULD HAPPEN.**”

*MAURICE HERLIHY*

# TRANSACTIONAL MEMORY: an idea ahead of its time

BY RICHARD LEWIS, BROWN PAUR

NEARLY 20 YEARS AGO, A BROWN UNIVERSITY COMPUTER SCIENTIST WAS WORKING ON A LARGELY THEORETICAL PROBLEM: HOW COULD MULTIPLE PARALLEL PROCESSORS MAKE CHANGES TO SHARED RESOURCES SAFELY AND EFFICIENTLY? THE PROPOSAL — TRANSACTIONAL MEMORY — IS SPARKING FRESH INTEREST AS A NEW GENERATION OF PROCESSORS SEEKS IMPROVED POWER AND SPEED.

In 1993, Maurice Herlihy and a colleague published a paper on transactional memory — a new, clever tactic in computing to deal with handling shared revisions to information seamlessly and concurrently. Few noticed.

Nearly 20 years later, transactional memory is an idea that's now the rage in hardware computing, and Herlihy, computer science professor at Brown University, has morphed into a prophet of sorts, a computing pioneer who was far ahead of his time. Intel recently announced that transactional memory will be included in its mainstream "Haswell" hardware architecture by next year. IBM has adopted transactional memory in the Blue Gene/Q supercomputer. The original paper by Herlihy and Eliot Moss has been cited more than 1,300 times.

"At the time, we thought (transactional memory) was really cool, but it was hard to attract attention to it — it was this specialized corner," Herlihy said. "We weren't necessarily geniuses ahead of our time, because it solved a problem that didn't exist yet."

The problem, as Herlihy explained it, was that core processors — the engines that program instructions — were changing in fundamental ways. As computers, along with their components got smaller and smaller, a single processor was unable to scale in size and still handle the data-lifting requirements. But multiple processors presented their own challenges: how to coordinate information sharing and revisions, in parallel and in real time.

At the time, processing was ruled by a series of locks, a kingdom where one thread held a key to the lock at any one time. This ensured that no other thread could pick the lock — modify a shared resource at the same time — but it also dragged down the transactional operating speed and efficiency.

"The trick was figuring out how to do this in a more efficient way," Herlihy said.

Herlihy, who had just joined the Brown faculty from a Cambridge, Mass., company called Digital Equipment Corp., and Moss, a computer scientist at the University of Massachusetts-Amherst, sought to design a system that would be more flexible. Their solution was simple and elegant. The pair dreamed up a system of requests and permissions, whereby operations are begun and logged in, but wholesale changes, or transactions, are not made before the system checks to be sure no other thread has suggested changes to the pending transaction as well. If no other changes have been requested, the transaction is consummated; if there is another change request, the transaction is aborted, and the threads start anew.

"We always said that parallel machines with more than one processor were going to be important someday, but nobody knew when it would happen," Herlihy said. "We were surprised that it did happen as we thought it would."

Transactional memory has been lighting up the computing technology chatterosphere in recent months. On the well-regarded Ars Technica site, a writer called transactional memory "a promising technique designed to make the creation of multithreaded programs easier." Intel advertises its form of transactional memory as "hardware (that) can determine dynamically whether threads need to serialize through lock-protected critical sections, and perform serialization only when required. This lets the processor expose and exploit concurrency that would otherwise be hidden due to dynamically unnecessary synchronization."

Although it was a long time coming, the buzz around transactional memory is "very satisfying," Herlihy said, modestly. "This shows the importance of long-range research."



# Dropbox in Space!

**BY ADAM COOK '13 AND  
ISAAC GOLDBERG '13**

Recently, Hack Week hit Dropbox in a big way. As interns, the two of us hadn't experienced the awesomeness of a Dropbox Hack Week, but when we were told that we could work on anything—absolutely anything—we knew we had to think big. We played around with a ton of project ideas, from real time collaboration tools to a Dropbox for Xbox app. But we decided to roll bold with a crazy idea: For years, Dropbox has let people take their stuff anywhere on Earth. But why stop there? Why not take Dropbox to space?



## INTRO

To do this, we decided to launch a high altitude helium balloon into the stratosphere. Attached were two Android smartphones: one programmed to take periodic photos, and the other to record video of the entire flight. At 100,000 feet above the ground, these photos and videos would capture the curvature of the Earth! In true Dropbox spirit, there's also an added twist: we wanted the balloon to have Internet the entire flight. With an Internet connection, we'd be able to use Dropbox's

brand new Camera Uploads feature to beam live photos from our balloon back to "mission control."

And it worked! Sort of.

## RESEARCH & PREPARATION

About two weeks before Hack Week started, we began researching high altitude weather balloons and the legendary shopping list needed to launch one — from the balloon itself to radar reflectors, parachutes, and oversized helium tanks. Thanks to a few pleading phone calls and lots of overnight shipping (thanks Amazon Prime!), everything arrived in time for Hack Week.

Our next challenge was figuring out how to hook our balloon up with Internet. Since standard cell phone 3G fails at high altitudes, we needed to find an alternative Internet source. We first considered using amateur radio. TCP/IP, the communication protocol of the Internet, has been implemented over amateur radio before, but for us to do so would probably require a Hack Year instead of a week. After (very) briefly investigating a 50-mile long Ethernet cord, we settled on WiFi—the very same WiFi you use every day.

Researchers have successfully broadcast a WiFi signal several hundred miles, so we were optimistic that we'd be able to shoot for a modest 50 miles. Although we expected our balloon to rise only 15 miles vertically, wind could carry it anywhere from 40 to 100 miles laterally, greatly increasing the needed range of our WiFi connection. We purchased a large parabolic dish along with other long-range WiFi equipment from Ubiquiti Networks.

## ASSEMBLY

Due to the tight power and weight restrictions on our balloon, our WiFi system was pretty complex. On the ground, we tethered a 4G Android smartphone to a laptop as our Internet source. The laptop was then connected to an antenna on our balloon which was connected to an extremely lightweight wireless router. Unfortunately, the wireless router aboard the balloon sported only an Ethernet jack, with no way to connect it to the Android phone.

Our solution was to connect yet another small wireless router to rebroadcast a wireless network for the onboard phone to pick up. And because there were no power outlets on the balloon, we cut open the Ethernet cord connecting the two wireless devices and spliced in two battery packs, one for each wireless device.

We also got a handheld radio with GPS to track our balloon in real time and properly aim our dish from the ground. Our plan was to use the GPS data from the balloon, our position, and trigonometry to aim the dish, even once we could no longer see the balloon. The radio would broadcast GPS information over an amateur radio network. Other radio enthusiasts would pick up the signal, and the balloon's position would ultimately be displayed on a website where we could view the position on Google Maps. We hoped that the balloon's altitude, high above the usual obstructions, would give us a consistent GPS signal.

With only two days before launch, we finally received our wireless equipment and started a mad dash to assemble it. Since the clock was ticking, we didn't get a chance to fully test our setup; the farthest distance we attempted was about half a mile. Come launch day, we could only hope that our setup would work over longer distances.

## LAUNCH DAY

Early Friday morning, we drove out to our launch site in Vacaville, CA. We chose Vacaville because we wanted a place that wouldn't carry our balloon into any urban areas or large bodies of water. We arrived in time for sunrise, but spent several hours looking for a clear, flat launch site with strong 4G coverage. Eventually, we were able to set up on a dead end road next to a small hotel.

We slowly began assembling the balloon starting with our wireless equipment. After a stressful couple of hours with several mysterious network failures, we secured the cameras and wireless devices in the styrofoam payload container. Next we began to inflate the balloon. Minutes before launch, we discovered that our GPS transmitter was busted. With no other choice, we packed the GPS device into our payload anyway, hoping that the strong signal it would get from high up would result in successful transmissions. We wrote our names and phone numbers on the sides of the container. If we were lucky, we'd receive a phone call if our balloon was found after a nice, gentle landing. It's probably best not to imagine what could have happened if we were unlucky.

Fully inflated, our balloon reached a size of about 8 feet in diameter. With the wind picking up, it was actually incredibly difficult to hold on to. We tied the payload, parachute, and radar reflector to the balloon, and after confirming that photos were appearing in our Dropbox account in real time, we were ready for launch. We aimed our dish, crossed our fingers, and let go of the

balloon. At almost exactly noon, several hours behind schedule, we launched!

The first few minutes after liftoff were incredibly exciting. The balloon rose quickly (more than 15 feet per second) and in just minutes was a small speck in the sky. For several minutes we successfully aimed our dish at the balloon, feeding it a WiFi signal which resulted in live photos uploaded over Dropbox. But the GPS data never materialized and eventually we were flying blind! We were soon left to search the sky with our dish, waving it back and forth and monitoring the strength of the connection, our only feedback for finding our increasingly invisible balloon.

We received photos in real time from our balloon for the first 3 or 4 minutes. While we maintained a network connection for many miles, we lacked the bandwidth to continue transmitting full photos as the balloon rose higher and higher. Nonetheless, we were incredibly excited by the few photos we received in real time.

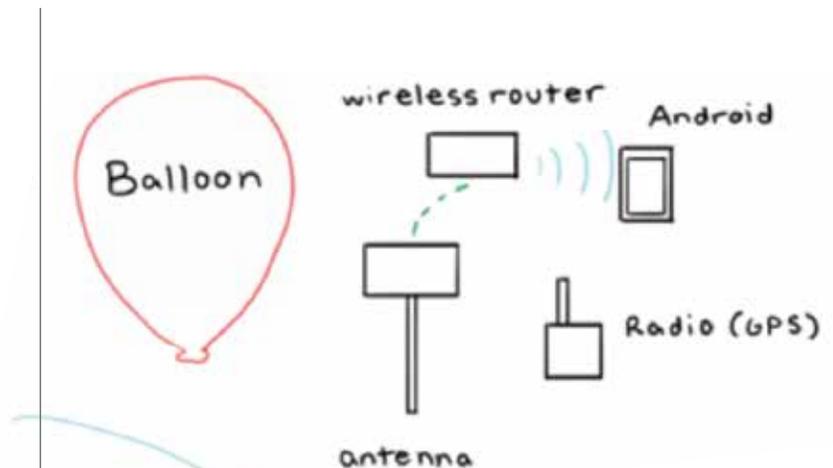
After attempting to recover an Internet connection for an hour or so, we decided to drive in the direction of our balloon's predicted landing. Incredibly, two hours into the flight of the balloon and likely moments after landing, we received a phone call: our balloon had been found! The caller informed us that she'd gone outside to investigate a commotion among her horses when she discovered our balloon! Unbelievably thrilled, we drove to her farm to retrieve our equipment and upload the remaining photos and videos to Dropbox. After conveying our many thanks (and converting a new customer to Dropbox!), we sped back to Dropbox HQ in time for Hack Week's closing ceremony.

We'd like to give a big shout out to everyone who helped us turn an ambitious project idea into reality. Thank you!

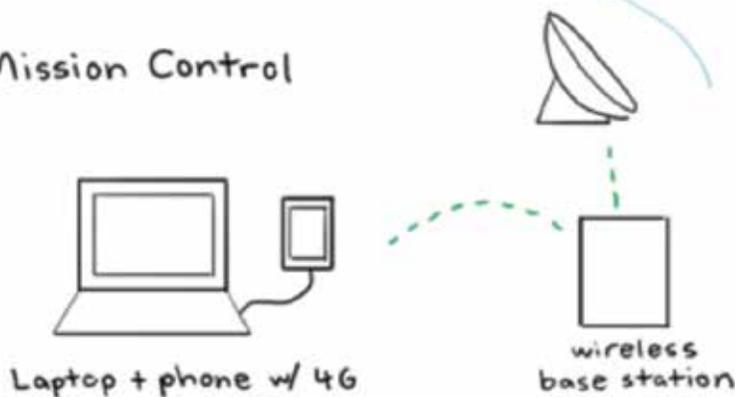
Check out the rest of the photos and videos from our flight!  
<https://www.dropbox.com/sh/2im4hk3ccxn7cqq/Saw7d-e1ei>

## WHAT WE USED

- 1200g Kaymont weather balloon: [http://www.kaymontballoons.com/Near\\_Space\\_Photography.html](http://www.kaymontballoons.com/Near_Space_Photography.html)
- Radar reflector: [http://davisnet.com/marine/products/marine\\_product.asp?pnun=00151](http://davisnet.com/marine/products/marine_product.asp?pnun=00151)
- 6ft Parachute: <http://www.the-rocketman.com/recovery.html>
- 2 Android Galaxy Nexuses
- Rocket M5: <http://www.ubnt.com/airmax#rocketm>
- Rocket Dish: <http://www.ubnt.com/airmax#dish>
- Bullet M5: <http://www.ubnt.com/airmax#bulletm>
- PicoStation: <http://www.ubnt.com/airmax#picostationm>
- AA and AAA Lithium Batteries



## Mission Control



## SOME GOOD RESOURCES

- [http://cdn.makezine.com/make/24/Make24\\_weatherballoon\\_11x17.pdf](http://cdn.makezine.com/make/24/Make24_weatherballoon_11x17.pdf)
- [http://weather.uwyo.edu/polar/balloon\\_traj.html](http://weather.uwyo.edu/polar/balloon_traj.html)
- <http://www.chem.hawaii.edu/uham/part101.html>
- <http://purefixion.com/attention/2006/03/long-distance-wifi.html>

# The Faculty Speak Out

Q & A WITH MICHAEL LITTMAN



Photo Credit: Mike Cohea

**How did you first become interested in computer science?**

The TRS-80 came out in 1977. I was 11 years old and I would go to the local shopping mall and try to stump it. I'd say: "print 1+1" and it said "2." I said "print 1+3" and it said "4." Ah! I said "print 1+1+1" and it knew that one too. How could a machine know so much about math? My parents ended up buying me one for my 13th birthday in lieu of a bar mitzvah and I was hooked, writing programs to do anything I could think of. My 7th grade algebra teacher fed my interest, giving me little math puzzles to try to solve via programming. By the time I was 15, I was no longer interested in growing up to be a doctor. Computer science was my path!

**How do you pick your research problems?**

One of the things I've found most successful is going to conferences and listening to what other people are talking about. Often, I'll hear an idea being discussed and it'll make me think — "No, that's not right at all. They should be thinking about it \*this\* way." Many of my papers are written as a kind of teaching exercise; I'm trying to convince the community that there's a simpler or more comprehensive perspective for understanding the problems they care about.

**What do you consider the most interesting and exciting challenges of your research?**

I work in reinforcement learning, which is about getting computers to learn from experience to improve their behavior. People and animals can learn this way and do amazing things. I find it fascinating and humbling to reflect on what knowledge and computation people bring to bear when they learn to accomplish tasks. I also really like the idea that we can think about people as reinforcement learners and ask if the algorithms we design shed any light on how human beings navigate their world. It's a thrill when a design insight not only helps us create smarter programs, but also teaches us something about how people might work.

**Do you have a favorite project that you've worked on?**

Some of the work that I'm most proud of is pretty technical, but the project that has been the most fun to talk about was a crossword solving program my students and I built. We competed in the American Crossword Tournament and I got to know some of the best puzzlers in the country. The design of the system itself was also very cool, drawing on insights from Bayesian inference, information retrieval and constraint satisfaction. Prof. Eugene Charniak gave me my all time favorite compliment for this work. After I presented the work at a seminar at Brown a decade ago, he said, "I should have thought of that." Eugene's taste in problems is exquisite, so it meant a lot to me to hear that.

**If you had enough extra time to study one additional area, what would it be?**

I've become very interested in the question: What would the world be like if programming knowledge were as widespread as reading and writing? These days, most devices we interact with have CPUs in them: phones, cameras, TVs, washing machines, cars. I know some people who have computerized pens! The behavior of these devices are controlled by computers and only a tiny fraction of the population has learned how to tell these devices what they want. Not only that, but the inherent flexibility of these devices is limited by the manufacturers — their programming interfaces are not exposed to the end users. But, imagine if everyone could program. We'd demand that our devices be allowed to listen to us instead of only running programs installed in the factory. I want to live in that world! I want to be able to tell my lamp to turn on when I say "lumos" or my coffee maker to play "java jive" when the coffee is ready. There are some great research problems here in terms of the design of the programming language, the network infrastructure through which they'd communicate, and the security mechanisms that would prevent people from messing with other people's stuff. There are also great opportunities to incorporate machine learning into this picture—sometimes the best way to tell a device what to do is to show it and have it learn from example.

I think Brown would be a great place to spearhead an effort in end-user programming given the history of outstanding work in interactive systems, machine vision, programming languages, and learning. Also, I feel like it's an effort students can readily contribute to and potentially have a huge impact on the world.

# Faculty Notes

## JOHN “SPIKE” HUGHES

I finished rewriting “Computer Graphics: Principles and Practice.” To be more accurate, I should say that Andy and I, and former students Morgan McGuire and Dave Sklar, and Kurt Akeley of Lytro, finished writing, with some help from Foley and Feiner as well, and comments and suggestions from a legion of volunteer readers. But I wrote most of it, so I feel the relief more keenly, I suspect. We now enter into a period of about 6 months of “production,” in which it goes from being lots of drawings and photos and LaTeX files into being an actual book. If you stop by the department and see someone walking on air...that’s me.

## SORIN ISTRAIL

Sorin gave invited talks: at Genopole in Paris, France; at the University of Southern California at the Symposium celebrating Mike Waterman’s 70th birthday, Simon Tavare’s 60th birthday and USC Computational Biology 30th birthday; at the Turing Centenary Conference, University of Cambridge, UK (two talks); at University of Rhode Island; and at Caltech in the Davidson Lab. He also gave an invited talk on the linkage disequilibrium measures unification problem at the “RECOMB Satellite on Open Problems in Algorithmic Biology” in St. Petersburg, Russia, meeting organized by Pavel Pevzner (UCSD). At the workshop he was invited also to lead a session on critical debate, with the same title as his upcoming article “Systems Biology Considered Harmful.” In the picture above, he is together with Professor Richard Karp of Berkeley who addressed Sorin’s intentionally provocative and irreverent criticism of the computer science contributions to the area to spark healthy scientific debate. During the conference Sorin had been wearing his Vincent van Gogh tie, honoring the high culture of the city of St. Petersburg, especially its famous Hermitage Museum.



*Professor Richard Karp and Sorin are debating “Systems Biology Considered Harmful”*

Sorin’s student Derek Aguiar presented a paper on creating a Human Genome Autism Deletions Map at the Intelligent Systems in Molecular Biology in Long Beach, CA. Derek also presented a poster with his new algorithm HapCompass for haplotype assembly from next generation sequencing data, now the state of the art software tool for this fundamental haplotype reconstruction problem. Austin Huang, now faculty in Biomed, published two other joint papers on HIV genomics and drug resistance. Alper Uzun, now faculty in Biomed, published a joint paper on preterm birth genomics. A number of students from Sorin’s Lab graduated: Ryan Tarpine, PhD, is now at Google, James Hart went to graduate school in biology at Berkeley, Tim Johnston, with an honor thesis Biomed award, went to graduate school in biology at Yale, Jake Franco, with an honor thesis, went Stony Brook Medical School; and David Moskovitz ’10 is now at Stanford graduate school in computational biology. Sorin’s newly launched Lab webpage gives more details on activities. Sorin is the faculty advisor of a new and very successful initiative due entirely to a

group of Brown computer science graduate students led by Irina Calciu: “Computer Science Without Borders” devoted to teaching smartphone software design to public high school students.

## SHRIRAM KRISHMURTHI

Shriram spent his spring on sabbatical in London.

When he noticed that his apartment was around the corner from the British Museum (his quickest times were 2m43s to the main gate and 2m58s to the Montague Place entrance), he decided to make it his goal to see everything on display: in particular, all the little bits and bobs that most people overlook. This took about thirty visits over the course of six weeks. His favorite visiting time was late Friday evenings, when the galleries are underpopulated, footsteps echo, the light is directed, and the Great Court is ethereal.

He admits to skimping a little on the wax seals and a little more on the coins. To this, Brown PhD student Betsy Hilliard replied, “The coins! Those are my favorite part!,” making him feel, after all this, like a dilettante. It goes to show you shouldn’t overlook anything.

The highlight of his trip is due to Philippa Gardner at Imperial College. When she heard of his plan, she arranged for them to get together with a friend of hers, who just happened to be the research director of the entire museum. He graciously gave them a wonderful little tour.

He now finds himself unable to step into a museum for a while.

In September he gave an invited talk in Deauville, which Claire Mathieu equated to Newport. Various details of the place conspire to suggest Claire may never have visited Newport. But Shriram did get to have dinner in Paris at his favorite Parisian restaurant, Le Potager du Marais, with his favorite Parisian person, Claire Mathieu.

**DAVID LAIDLAW & BARB MEIER**

We continue our usual teaching and research efforts, but particularly enjoyed our summer vacation this year. Together with our sons Cassidy, 15, and Eliot, 12, we bicycle-toured the Icefields Parkway from Banff to Jasper, two Canadian National Parks in the Rocky Mountains of Alberta. The trip was spectacular – if those parks aren't on your bucket list, they should be! Numerous bears, hundreds of kilometers of biking, climbing two mountain passes, glaciers, a dozen campsites, not quite enough showers, and no cell service (let alone internet) characterized our trip. David carried and drank a lot of Starbucks Via instant coffee, with only one emergency near the end of the trip when the supply ran out! Logistics were especially challenging, but Barb chased down the airline with the best bicycle policy (Air Canada), David designed and implemented an optimal bicycle packing algorithm, and we found that the best storage options are sometimes hotels that will keep your car or bikes for you while you are elsewhere. Perhaps not the kind of vacation everyone appreciates, but we had a great time!

**MICHAEL LITTMAN**

Michael returned to College Hill this semester and has hit the ground running. In addition to teaching his Learning and Sequential Decision Making course, he also gave an invited lecture at the International Conference on Grammatical Induction in Washington, DC and sat on a panel at the Grace Hopper Celebration of Women in Computing Conference titled, "If I'd Only Known!" where senior faculty shared their experiences in successfully navigating the tenure and promotion process.

**ERIK SUDDERTH**

In an active June, Erik gave a standing-room-only tutorial on "Applied Bayesian Nonparametrics" at the IEEE International Conference on Computer Vision and Pattern Recognition (CVPR). Several graduate students from his group also presented papers at CVPR, which was held right here in downtown Providence. Erik then departed for Edinburgh, Scotland, where he enjoyed stunning scenery and the International Conference on Machine Learning (ICML).

This fall, Brown's new Institute for Computational and Experimental Research in Mathematics (ICERM) is holding a program on "Computational Challenges in Probability." Erik was excited to co-organize a September workshop and tutorial, which brought together experts from around the world to discuss recent innovations in statistics and machine learning.

**JOHN SAVAGE**

John has continued his involvement in cybersecurity. In March he and Melissa Hathaway co-authored an article entitled Stewardship of Cyberspace: Duties for Internet Service Providers that was published by the Munck School of Global Affairs at the University of Toronto. In June he served as panelist on Cybersecurity and the Law at the USENIX Hot Topics in Cyber Law workshop in Boston, MA. In the same month he attended the Cyber Doctrine Workshop as a member of the Core Group organized by the Battelle Institute in Virginia Beach, VA. In September he served as a member of the Evolution of Western Internet Governance panel at the Cyber Norms Workshop 2012 held at MIT. On May 3 he organized a conference at Brown under the auspices of the Watson Institute entitled Cybersecurity and International Relations. The conference was opened by President Simmons, graced with the presence of Congressman Langevin of Rhode Island, co-founder of the House Cyber Caucus, and informed by seven distinguished cybersecurity specialists who were each introduced by a different Brown undergraduate. Last spring he taught a course with the same title as the conference to 44 students. He continues to serve on the Nominations Committee of the Faculty and the Executive Committee of the Department.

He reports that he finally submitted the manuscript for the 3rd edition of Computer Graphics: Principles and Practice to the publisher. With luck, it'll actually be printed sometime in the Spring. Now all he has to do is (a) catch up on email, and (b) figure out what to do next.

## Checking in *with* Barb Meier

Barbara Meier brings a painter's eye and an artist's technique — and significant experience in California film and animation studios — to her teaching and research in computer graphics and animation at Brown.



Photo Credit: Mike Cohea

Her curriculum vitae has things most academic CVs have: papers published in journals, invited talks at conferences, editorial service at professional journals. But Barbara Meier's route to the Computer Science faculty at Brown has *lots* more: Klingons, Batman, a near miss on an Oscar, credits on several feature films, and three music videos with Michael Jackson.

Yes, *that* Michael Jackson, the Gloved One.

"He was just coming off *Thriller*. He had tons of money and wanted to do something really state of the art next. That was *Black or White*," Meier said. "Our part was morphing the faces of 14 dancers and models while they were doing the dance routines. It became an iconic piece of music video in the early 1990s. Michael came to our studio and I met him. He was incredibly soft-spoken in person, but on the set when they said 'Action,' he was the most confident, dynamic actor I'd ever seen."

Meier came to Brown in 1979 as a physics concentrator, expecting also to do a lot of work in visual art. Those plans changed, as plans often do at Brown. She signed up for introductory concentration courses in both physics and computer science.

"My adviser convinced me that taking both was not the best idea. I went to the first physics lecture; it was interesting but dry. Then I went to Andy van Dam's class and it had skits and theater and was so dynamic. I figured that if I had to choose one, this was definitely it."

Computer graphics also meant she could continue her interest in art. She took classes at RISD, mostly in photography and animation, and worked her way through two Brown degrees in computer science (A.B., 1983; Sc.M., 1987). Her graduate project involved palette selection, demonstrating that an expert system could present an initial set of colors for further tuning by a human expert.

After additional work in experimental animation and filmmaking at the School of the Museum of Fine Arts in Boston, she moved to California, where she worked as a visual effects animator, technical supervisor, and art director.

"I did some work on painterly rendering when I was at Disney — getting computer-generated images to look more like work done with traditional media — and wrote a paper on it. Those ideas blossomed into a field called non-photorealistic rendering. You can see it in TV commercials," she said. "It was used in a feature film, *What Dreams May Come*, in which Robin Williams wakes up in heaven — a painted world, because his wife was a painter. It was a *very* dark movie — I don't recommend it — but that scene was really cool. It was the first time the technique was used, and it won an Oscar for best visual effects."

(That was the near miss on an Oscar. After presenting the paper by videoconference from California to New Orleans, Meier gave birth to a son. She had to decline a subsequent offer to be the visual effects supervisor on the film. Years later, her grown son gave her a small Oscar of her own, which sits on a bookshelf in her office with other souvenirs of the film industry.)

She and her husband David Laidlaw, professor of computer science, came back East in 1998 and returned to the Department of Computer Science at Brown. She became a researcher in non-photorealistic rendering, then a visiting lecturer teaching the 3-D animation course (2003-06), then adjunct assistant professor adding a second computer animation course (2006-12), and now a member of the regular faculty as a Senior lecturer.

"Making a film or an animation — that's the focus of my teaching now — is normally a collaboration of 300 people at a place like Pixar. A single person making a film is rare," she said. "At Pixar they always focus on the story. If the story doesn't work, it doesn't matter how beautiful it is or if everyone's clothes and gestures are perfect and the grass blows in the wind just so. I ask my students about every detail: Does it support the story? They only have a limited time to complete their projects. They have to choose the best detail. Always."

The stories she and her students work on are not patterned after heroic Hollywood dramas or Disney fantasies. The starting point is more likely to be about conflicts or experiences on a smaller scale — the first day of school, for example — in which people can recognize their own lives and experiences. By design, her students in CS 125 go through the entire production pipeline in a single semester: making geometric models, putting surfaces on them, putting those objects into a scene, lighting the scene, deciding angles from which to film, animating, rendering. It has acquired the reputation as one of the most time-intensive classes on campus, Meier says.

"Consistently in their evaluations at the end of the semester, students will say, 'This was the most time-consuming, *but* the most fun *and* the most rewarding project I've done at Brown.' So I know I'm doing something right. They are incredibly proud of their work. We have a screening at the end of the semester, and they bring their friends. It's been standing room only for the last few years; I've got to find a new room."

# Meet New Faculty Member Paul Valiant

The spread of computation throughout the sciences is not just a matter of crunching numbers, Paul Valiant observes. The “algorithmic mindset” is also rapidly spreading its reach. He quotes Edsger Dijkstra: “Computer science is no more about computers than astronomy is about telescopes.”

In one form or another, Big Data has found a role in academic disciplines from literature to particle physics. New computing machinery, blazing fast and muscular, puts access to unimaginable quantities of information at the tip of a mouse.

**“YOU GET THE SENSE THAT PROFESSORS AROUND HERE ARE VERY WILLING AND ABLE TO TRUST EACH OTHER’S JUDGMENTS, TO WORK WITH EACH OTHER ON PROJECTS. THINGS SEEM TO WORK VERY FLUIDLY.”**

Paul Valiant is intrigued by the sudden emergence of the Big Data metaphor and how it intersects and informs his research. “The thing that surprised everybody about Big Data was that for some problems all you have to do is use known methods — but apply them to the entire content of Wikipedia and half a million books scanned. A computer can win Jeopardy,” he said, referring to IBM’s Watson computer system that faced off against Jeopardy champions last year and won.

“For some problems, the data does stuff for you that people used to think required a conceptual breakthrough.” Another example he raised is the recent data-driven success of tools to translate text between English and other languages.

Whether mediated by Big Data or not, the spread of computation — computer science

— across the academic landscape and deep into disciplines presents opportunities for conceptual advances. “As the long synergistic history of mathematics and physics attests, the benefits flow both ways,” Dijkstra once wrote. “Newton’s mathematical accomplishments, for example, cannot be understood except in light of the developments in mechanics he was pursuing. Thus it may be hoped that when the interconnections between computation and the other sciences have reached a similar level of maturity, corresponding fruits will have been gained on both sides.” The essential philosophy, he said, is to engage, to be willing “to get one’s hands dirty in the service of the right problem.”

Protein folding is a case in point. Proteins are built as long chains of amino acids which interact with each other to fold up into an arsenal of molecular machines which collectively run our bodies. Correct folding is essential, akin to the correct assembly of an industrial machine, but the body has no blueprints; its machines must assemble themselves following trillions of exquisitely sensitive interactions of the laws of physics. There has long been the hope that computers could predict how proteins fold, sidestepping a painstaking protein-by-protein effort of biology labs worldwide, but current approaches would still take hundreds, even thousands of years to simulate the single second that a typical protein takes to fold.

Conceptually, however, there is strong evidence of exploitable structure — natural rules that would substantially reduce the complexity of the search for the folded state. The Foldit Project, a videogame-like crowdsourcing Internet site, asks users to fold components of a protein in ways that require the least amount of energy — and then scores their attempts.

“I’m not a user-interfaces guy or a crowdsourcing guy. I’m a theory and algorithms guy,” Valiant said. “But what Foldit demonstrates is that there is structure to the problem. We weren’t sure if there was structure to grab onto, but the fact that humans can do it at all is proof of concept. Foldit tells us that there are algorithmic breakthroughs waiting to happen.”

Toward that end, Valiant will be offering a graduate-level course in protein folding this semester, but in an advanced, real-time, 3-D way. “Seeing things in 3-D helps your brain, so we’ll give the brain the tools it wants,” he said. “I’ve bought some 3-D glasses, those red and blue things, which I’ll hand out to students. They’ll have six-degrees-of-freedom joysticks to push, bend, or twist the protein in three dimensions. And we’ll do it live at body temperature.”

Valiant’s path to an assistant professor appointment at Brown began early, growing up in a household fascinated by math and science. There was a second-grade project in the finer points of Microsoft Basic. In his early teens, there was an encounter with a college-level computer science textbook by Andries van Dam and John Hughes, a gift from his father. At Stanford, there was undergraduate work in physics and math (B.S., physics and math, 2004), but a graduate-level turn toward computer science (M.S., computer science, 2004). He completed his formal studies at MIT (M.S., computer science, 2007; Ph.D, 2008) and did postdoctoral work at MIT and the University of California–Berkeley, his last post prior to Brown.

What brought him to Brown? “It had something to do with the department being small and communicating very well,” he said. “You get the sense that professors around here are very willing and able to trust each other’s judgments, to work with each other on projects. Things seem to work very fluidly.”

That and a sense expressed by former department chair Eli Upfal that Brown’s collaborative culture would be a wonderful fit for a young computer scientist deeply involved in “interdisciplinary theory.”

# Department Awards and Honors

## UGUR ÇETINTEMEL AND SHRIRAM KRISHNAMURTHI PROMOTED TO PROFESSOR

The Department is excited to announce the promotions of Ugur Çetintemel and Shriram Krishnamurthi to Professor, effective July 1, 2012. “These faculty members are internationally respected and highly visible in their areas of expertise and have a strong commitment to teaching and advising,” said Department Chair Roberto Tamassia. “We are delighted that the University has recognized the outstanding work of Ugur and Shriram by promoting them to a higher academic rank.”

### Ugur Çetintemel

Ugur specializes in the management and analysis of data at scale. His recent focus has been on developing systems and techniques for real-time analytics. He is also researching methods to support interactive exploration and analysis of big data.

Ugur joined the department in 2001 after completing his PhD at the University of Maryland, College Park. Ugur is currently serving as the PC co-chair for VLDB 2012 and was the general co-chair of ACM SIGMOD 2009. He also serves as an associate editor for the VLDB Journal, Distributed and Parallel Databases Journal and the ACM SIGMOD Record.

He is the recipient of an NSF CAREER award and was a Brown University Manning Assistant Professor. He has been PI or co-PI for multiple projects supported by NSF, NVIDIA, Microsoft, MITRE Corporation, the Army Medical Research and Materiel Command, and private foundations, with overall funding exceeding \$6M. Ugur is also a co-founder and a senior architect for StreamBase Inc., a high-performance analytics company.

### Shriram Krishnamurthi

Shriram joined the department in 2000 after receiving his PhD in Computer Science from Rice University. He currently focuses on securing various attack surfaces on the Web through the lens of programming languages. With collaborators, he has created several influential systems: DrRacket (programming environment), Margrave (access control policy analyzer), FrTime and Flapjax (reactive programming languages), and JSWebTools (a suite of semantics, types, and tools for JavaScript and Web browsers). He is a co-author of *How to Design Programs* and author of *Programming Languages: Application and Interpretation*.

He serves on multiple editorial boards and has given several keynote talks. He is the recipient of an NSF CAREER award and of a Henry Merritt Wriston Fellowship from Brown for distinguished contribution to undergraduate education. He has research funding

from NSF and several corporations and foundations.

Shriram is passionate about improving introductory computer science education. He has worked tirelessly through the Program by Design (formerly TeachScheme!) project to provide educators with the tools needed to address the fundamental problems that students face during their early computer science coursework. In addition, Shriram has been instrumental in the development and implementation of Bootstrap, a standards-based curriculum for middle-school students, which teaches them to program their own video games using purely algebraic and geometric concepts.

## ÇETINTEMEL, LAIDLAW & ZDONIK AMONG THE INVESTIGATORS OF THE NEW INTEL SCIENCE AND TECHNOLOGY CENTER FOR BIG DATA

Ugur Çetintemel, David Laidlaw and Stan Zdonik are part of the newly launched Intel Science and Technology Center (ISTC) in Big Data. The center is based at the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT. The center is primarily affiliated with the Intel Parallel Computing Lab.

The goal of the ISTC is to produce new data management systems and architectures that can help users process “big data” — data collections that are too big, growing too fast, or are too complex for existing information technology systems to handle. The center will also demonstrate the effectiveness of these solutions on real applications in science, engineering, and medicine.

In addition to Çetintemel, Laidlaw, and Zdonik, the center includes leading researchers from MIT, Portland State, Stanford, Tennessee, UCSB, and Washington. Their research spans data-intensive scalable computing, machine learning, computer architecture and domain sciences (genomics, medicine, oceanography, imaging, and remote sensing).

The center is focused on five major research themes:

1. Databases and Analytics: new software platforms for processing massive amounts of data and applying analytics beyond what conventional relational systems can do.
2. Math and Algorithms: algorithms for linear algebra, signal processing, search, and machine learning that scale to tens or hundreds of machines and petabytes of data.
3. Visualization: visualizations and interfaces that allow users to interact with massive data sets, on displays ranging from phones to video walls.
4. Architecture: data processing systems that leverage next generation hardware innovations, such as many-core chips, non-volatile random-access memories, and reconfigurable hardware.

5. Streaming: data processing systems and algorithms that facilitate rapid processing and ingest of data streams.

Zdonik observes, “This project should have a profound impact on the way science and complex analytics are done in the future.”

Çetintemel says, “We invite the broader data science community to collaborate with us in this important effort.” Laidlaw adds, “This will be a great opportunity to bring together visualization and big data.”

### **MAURICE HERLIHY WINS SECOND EDSGER W. DIJKSTRA PRIZE**

Maurice Herlihy, along with co-author Eliot Moss, was awarded the 2012 ACM-EATCS Edsger W. Dijkstra Prize in Distributed Computing. This Prize is awarded to outstanding papers on the principles of distributed computing, whose significance and impact on the theory or practice of distributed computing have been evident for at least ten years.

The 2012 Edsger W. Dijkstra prize was awarded to Maurice Herlihy and Eliot Moss for their paper “Transactional Memory: Architectural Support for Lock-Free Data Structures,” and to Nir Shavit and Dan Touitou for their paper “Software Transactional Memory.”

These papers pioneered the idea that concurrent programs should synchronize with one another via transactions, blocks of code that appear to execute atomically. Transactions are easier to use than conventional synchronization methods, and are widely used in databases. Nevertheless, transactions were considered too heavy-weight to support directly either in hardware, or in general-purpose programming languages.

Herlihy’s paper described how modern multiprocessor architectures can support transactions directly in hardware, through simple modifications to standard cache coherence protocols. First published in 1993, this idea was slow to catch on, but in 2012, it was announced that both IBM’s BlueGene/Q supercomputer and Intel’s Haswell processor would provide support for transactional memory in hardware, ensuring that hardware transactional memory is here to stay.

Maurice’s previous Dijkstra Prize was in 2003 for the 1991 article, Wait-Free Synchronization.

### **SHRIRAM KRISHNAMURTHI WINS SIGPLAN ROBIN MILNER YOUNG RESEARCHER AWARD**

Shriram Krishnamurthi was recently awarded the first ever SIGPLAN Robin Milner Young Researcher Award. The award was given by SIGPLAN, ACM’s Special Interest Group on programming languages, to recognize outstanding contributions by young investigators in this area.

The official award announcement refers to Shriram as “a prolific researcher who brings programming language theory to bear in many other disciplines, thus exposing its foundational value” and notes that his research contributions “range from type soundness proofs for Java and influential extensions thereof, through foundational aspects of web programming, to model-driven development and empirical studies.” It further indicates that “Shriram is also an influential educator, reaching out beyond the university to infect school kids with algebraic thinking.”

Robin Milner, who passed away in 2010, was a leader in programming language research, developing many of the ideas that now form the backbone of the field. Among Milner’s biggest gifts to the field was his passion for mentoring and nurturing young colleagues, many of whom have grown into world leaders in their own right. This award was established in his name to further encourage new generations of outstanding researchers.

### **MICHAEL LITTMAN RETURNS TO BROWN WITH PROFESSOR APPOINTMENT; TIM KRASKA AND PAUL VALIANT TO JOIN THE DEPARTMENT AS ASSISTANT PROFESSORS**

The Department is thrilled to announce the addition of three new faculty members for the 2012-2013 academic year. PhD alum Michael Littman ’96 and Paul Valiant will begin teaching in September and Tim Kraska will join the department in January.

Michael previously spent many years as the director of the Rutgers Laboratory for Real-Life Reinforcement Learning and served as the department chair from 2009 until June 2012. His expertise includes artificial intelligence and machine learning. Tim will come to Brown after serving as a postdoctoral scholar at the University of California at Berkeley, working in the AMP Lab on Big Data management and hybrid human/machine database systems. Paul is also a postdoctoral scholar at the University of California at Berkeley in the Theory of Computation group. He received his PhD from MIT and his interests include cryptographic and algorithmic game theory and coding theory.

Our three new faculty members will help serving our growing population of graduate and undergraduate students. “We are thrilled to have these three exceptionally bright and talented scholars join our department,” said Chair Roberto Tamassia. “We are all looking forward to welcoming them to Brown in the coming academic year.”

#### **Michael Littman**

After earning his PhD from Brown University in 1996, Michael worked as an assistant professor at Duke University, a member of technical staff in AT&T’s AI Principles Research Department, and was most recently associate professor and chair in the computer

## DEPARTMENT NEWS

science department at Rutgers. He is on the executive council of the American Association for AI, the advisory board of the Journal of AI Research, and serves as an action editor of the Journal of Machine Learning Research.

His research in artificial intelligence focuses on designing software systems that improve their behavior with experience. His educational focus is on making academic computer science accessible to the general public.

“It’s a dream come true to be coming back to Brown,” said Michael. “When I was here as a student, I was very focused on my narrow research area. This time, I’m very excited to get to know the undergraduates and to work with faculty both within and outside Computer Science. It’s a very exciting time to be a Computer Scientist and I would love to see the whole Brown community benefiting from the fantastic opportunities enabled by our ideas.”

### Tim Kraska

Tim received his PhD from the Swiss Federal Institute of Technology Zurich (ETH) in Switzerland, master’s degrees from Westfälische Wilhelms-Universität Münster in Germany and University of Sydney in Australia and a Bachelor of Science in Information Systems also from Westfälische Wilhelms-Universität Münster. He received a Swiss National Science Foundation Prospective Researcher Fellowship (2010), a DAAD Scholarship (2006), a University of Sydney Master of Information Technology Scholarship for outstanding achievement (2005), the University of Sydney Siemens Prize (2005), and a VLDB best demo award (2011). Tim’s current focus is on Big Data management and hybrid human / machine data base systems.

According to Tim, “Brown’s strong inter-disciplinary and friendly environment with its excellent faculty and students make it a truly outstanding university. I am very excited to be joining the CS department and to be part of making it one of the leading places for big data research.”

### Paul Valiant

Paul received his PhD from MIT and master’s degrees from both MIT and Stanford and a Bachelors degree from Stanford. He was previously a postdoctoral researcher at MIT. Paul received a NSF Mathematical Sciences Postdoctoral Research Fellowship, the Best Student Paper Award at the Theory of Cryptography Conference in 2008 and a National Defense Science and Engineering Graduate Fellowship. His interests include statistics, learning and property testing; cryptography; auctions and game theory; protein folding; evolution; fluid dynamics and computational approaches to the other sciences.

“I am very excited to be joining the collaborative and forward-looking community of Brown’s Computer Science Department,” said Paul. “Computation has been constantly challenging us to change how we think about the world, and I am particularly intrigued by the new perspectives it offers on deep problems in the other sciences. At Brown I look forward to engaging with students and faculty from many departments and backgrounds to learn how to tackle these challenges.”

### BARBARA MEIER APPOINTED SENIOR LECTURER

The department is thrilled to announce that Barbara Meier ’83, Sc.M. ’87, has been promoted to Senior Lecturer. Barb teaches computer animation, where she focuses on aesthetics and storytelling as much as technical aspects in her courses which include Introduction to Animation and Intermediate Computer Animation.

Before teaching at Brown, Barb worked as a visual effects animator for feature films and music videos when computer graphics production was just beginning to have a place in Hollywood. She worked with and learned from many talented computer graphics artists, feature film directors, visual effects supervisors, and producers. Barb is also involved in research projects in the areas of artistic (non-photorealistic) rendering and in the use of color in computer graphics.

“I’m personally delighted with Barb’s promotion to Senior Lecturer, the first such position in our Department’s history,” said Andy van Dam. “Barb’s courses are known as among the very best (and most intense and oversubscribed) courses in our department, and her dedication to her classes and her students is legendary. Barb’s extensive personal experience as computer scientist and visual effects artist inform her ‘studio courses’ in animation and they offer a wonderful complement to the more traditional computer-science-oriented graphics courses we teach. These are magnet courses not just for computer science students interested in computer graphics imagery in films and video games, but also students with such interests from other sectors of campus. Brown’s undergraduates are especially in demand in these industries because they combine computer science competence with production experience.”

### PH.D. STUDENTS CONNOR GRAMAZIO AND MARK LEISERSON RECEIVE NSF GRADUATE FELLOWSHIPS

Computer Science PhD students Connor Gramazio and Mark Leiserson recently received fellowships from the National Science Foundation's Graduate Research Fellowship Program, a prestigious and highly competitive program.

Connor Gramazio is interested in researching interactive visualization, and how such systems can be used to explore and analyze the ever-increasing amount of data that surround us. He is currently developing a new indexing method for geospatial-temporal data to improve the scalability and efficiency of interactive visualization of such datasets. Connor is advised by David Laidlaw.

Mark (Max) Leiserson is currently a PhD student in the Center for Computational Molecular Biology. He is working in the field of cancer genomics, investigating the differences in the DNA of normal and cancerous cells and is advised by Ben Raphael.

The NSF Graduate Research Fellowships provide three years of support leading to research-based master's or doctoral degrees and are intended for individuals in the early stages of their graduate study in the fields of science, technology, engineering and mathematics. Awards are granted based on previous research experience, the proposed plan of research, and the student's ability to make a "broader impact" in their program of study in terms of educational, industrial, and societal relevance. NSF Fellows are expected to become experts who can contribute significantly to research, teaching, and innovations in science and engineering.

Since 1952, NSF has funded 43,000 Graduate Research Fellowships out of more than 500,000 applicants.

### NABEEL GILLANI '12 RECEIVES BROWN UNIVERSITY DISTINGUISHED SENIOR THESIS AWARD

Nabeel Gillani was awarded the 2012 Brown University Distinguished Senior Thesis Award for his honors thesis, Joint Assessment and Restoration of Power Systems. Pascal Van Hentenryck was Nabeel's advisor and recent PhD recipient Carleton Coffrin's research was the starting point of the thesis.

The award recognizes exemplary senior thesis projects by undergraduate students across the university. Award recipients exemplify the range and quality of undergraduate research at Brown University. Each finalist makes an important and original contribution to an academic discipline, and all finalists provide lucid explorations of important issues and questions of interest to today's educated readers.

In 2012, Nabeel was also the first Brown computer science student to be elected to the American Rhodes Scholar Class and was selected from a pool of 830 candidates.

### THREE DAY STARTUP SUCCESSFULLY LAUNCHED AT BROWN

Undergrad Anne Kenyon founded Brown's 3 Day Startup (3DS) weekend, which was held in early April with the support of the department, Google, 10Gen, and Teespring.

The idea of 3 Day Startup is simple: start a technology company over the course of three days. Work space was available for an entire weekend, 25 students with a range of backgrounds were selected and top-notch entrepreneurs and investors were onsite to help pick the best ideas for software startups during the Friday brainstorming session. Students then worked to release a minimal prototype by Sunday night, when they gave their product presentations. The goal of 3DS is to build enough momentum among a network of motivated people to sustain a company beyond the weekend.

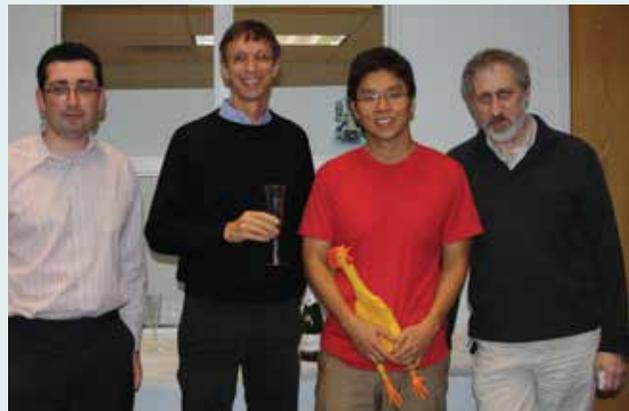
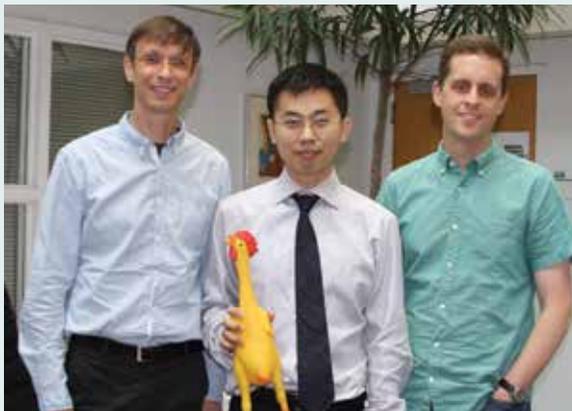
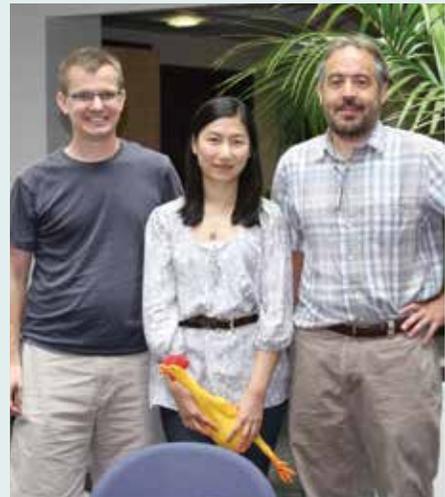
"Many students at Brown have cool startup ideas, and all have different skill sets, so they need a way to meet and see each other in action — working together for three straight days is a perfect way to find those with whom you work well to accomplish something of value," said Anne. "Everyone seemed to get a lot out of the weekend, particularly from the mentors who have insight based on years of experience — they said things I would never have thought of, but make so much sense. Makes us realize how much we have to learn, that business is really non-trivial."

3DS is an academic program designed to teach entrepreneurial skills in an extreme hands-on environment and enable students to start companies. The 3DS program brings together students ranging from freshmen to freshly-minted PhDs, with diverse backgrounds, including computer science, business, engineering, law, design, communications and others. Participants gain experience in cross-disciplinary collaboration, brainstorming and ideation, and group productivity, including ad-hoc leadership and decision-making under severe time constraints.

3DS is way more than a hackathon and we were more than coders. We went out and collected customer feedback as we rapidly assembled and programmed our live demo. We had to quickly fix complaints and adopt suggestions. Everything was in flux; I had never experienced anything like it," said attendee Ryan McVerry.

In addition to Anne, David Borcsok, Gabi Lewis and T. Luke Sherwin all of Brown, helped to organize the event. Mentors included CS alums Spiros Eliopoulos (Co-Founder, CTO Tracelytics) and Keith Dreibelbis (Google).

# Recent PhDs



CLOCKWISE FROM TOP LEFT

- Anna Ritz
- Nathan Backman
- Wenjin Zhou
- Deging Sun
- Cagatay Demiralp
- Shay Mozes

# Artemis 2012

This summer marks the completion of the 17th year of the Artemis Project, a five-week camp for rising ninth grade girls that teaches them about computer science and technology.

With help from advisor Stan Zdonik, four Brown undergraduates, Annie Carlson '14, Jinqing (Melanie) Li '14, Parielle Lacy '15, and Elyse McManus '15, and one University of Maryland undergraduate, Catherine Rossbach '15, put together lesson plans to teach twenty local girls about a multitude of topics including modern applications like Photoshop, programming languages such as Python, and theory like the prisoner's dilemma. Artemis aims to empower girls in their ability to understand and enjoy computer science by exposing them to a variety of topics related to the field.

The first week of camp focused on teaching the girls how to use various computer applications. The girls got hands-on experience with the applications by completing various projects, such as Photoshopping photos of themselves with pictures of celebrities, designing personalized web pages using Dreamweaver, and managing business expenses using Excel. Next, the girls were introduced to programming using Alice, an introductory programming language that teaches coding concepts using a visual 3D environment. With Alice, the girls were able to create their own visual interpretations of excerpts of *Alice in Wonderland*, a project that many of them enjoyed. After being introduced to programming concepts, the girls moved on to learn Python, where they coded various versions of Nim, starting with implementing a basic AI, then building on their existing code to create a smart AI, and finishing

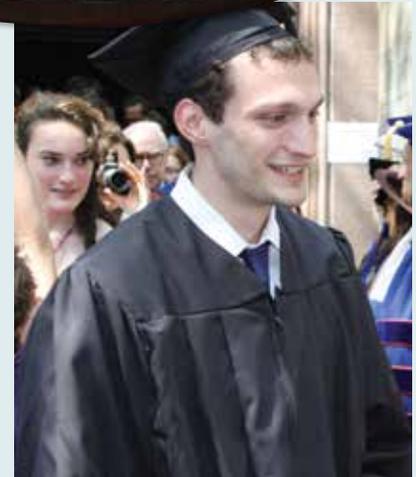
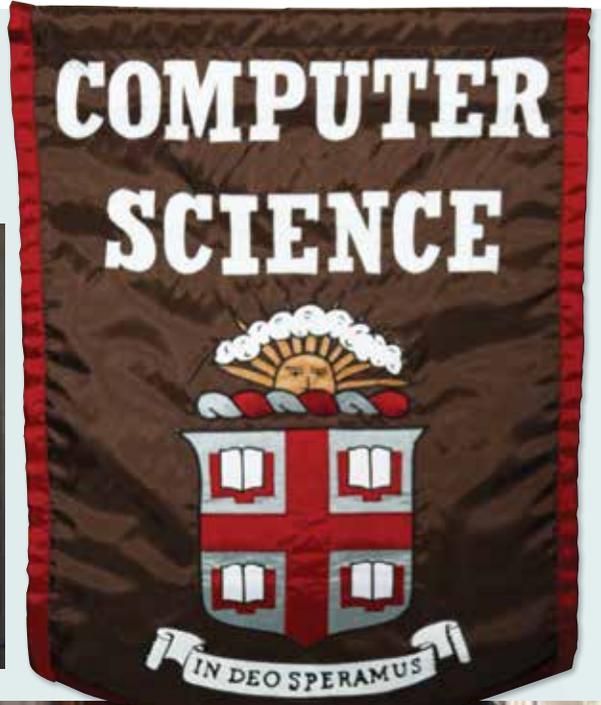
the project by completing a learning AI. During the last week of camp, the girls put their coding skills to the test by programming Vex robots in easyC in order to navigate their way out of a maze.

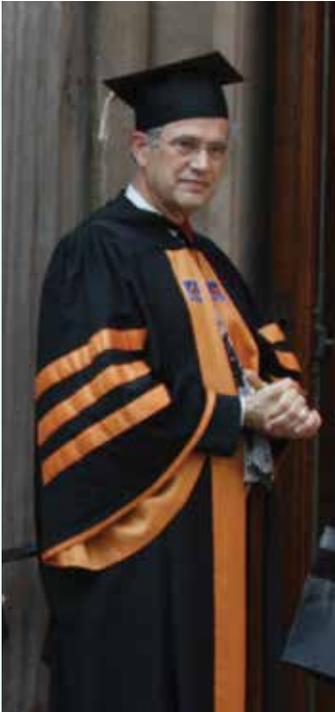
When not completing projects and practicing their coding, the girls learned about various computer science concepts, like cryptography, binary, logic, simple data structures, pathfinding, game theory, artificial intelligence, and machine learning. In addition to learning by completing handouts and participating in some demonstrations, these concepts were further explored through lectures given by guest speakers, consisting of Brown faculty and graduate students, and representatives from software companies like Google and Microsoft. The guest speakers touched upon topics covered in class and went even further, giving the girls a better grasp of how the concepts they learned about in class connected to computer science from a professional perspective.

Outside of the classroom, the girls were able to have more interactive experiences through the four field trips Artemis held. The first field trip was to the Wheeler School Ropes course in Seekonk, Massachusetts. This was a great opportunity where the girls got to know each other better and were able to bond over teambuilding exercises. The next field trip was to MIT where the girls got to explore the MIT museum and visit their AI lab. The next week the girls returned to Boston to visit the Boston Museum of Science. The girls were exposed to many facets of science through the various exhibits. The last field trip was on the final day of camp. These field trips gave the girls a different perspective of science and technology that extended outside of a lecture hall or a computer lab. The girls went to the United Skates of America, where they had a fun day skating and playing around before saying their goodbyes.

Towards the end of camp, the girls researched a topic related to computer science that they found interesting and presented their findings to their parents and Brown faculty. The girls were very excited to present on topics such as security, number theory, artificial intelligence, and imaging technology, among others. The presentations were received by their parents and faculty with enthusiasm and praise for the girls' comprehension of the subject matter. Overall, the girls had a wonderful time and their parents appreciated the hard work that was put into the camp.

# Commencement





# In first for U., prof offers online computer science class

REPRINTED FROM THE BROWN DAILY HERALD, SEPTEMBER 17, 2012

BY KATE NUSSENBAUM, SENIOR STAFF WRITER

Two weeks ago, Dean of the College Katherine Bergeron announced via email that three Brown courses will soon be available online for free worldwide through the Coursera platform. But one computer science professor, Shriram Krishnamurthi, has already begun offering an online version of his course CSCI 1730: “Programming Languages.”

Krishnamurthi said his decision to offer the course both in-person and on the web was independent of the University’s move toward online education. By the time the University announced its plans to offer online courses, Programming Languages already had 600 sign-ups.

## ONLINE ATTRACTION

Of the approximately 1,600 participants enrolled in Krishnamurthi’s course, most are professional programmers, clustered in the northeastern U.S., California, Western Europe and India. Others are high school students, and some are professors who know the material but are interested to see how Krishnamurthi runs his class.

Krishnamurthi anticipates that about 100 students will complete the course among those initially enrolled. Between 400 and 500 students submitted the course’s first quiz.

Krishnamurthi said he intentionally made the first assignments difficult so students would know what they were in for — Programming Languages, he noted, is not an introductory course, and students across the country may not know what is expected in a Brown class.

The professor stressed the importance of keeping up with peers that are forging ahead with online learning.

“You either grow or ossify,” Krishnamurthi said. “If we don’t do this, we’re going to take a serious reputational hit. All the other major universities are doing it — students talk about the schools where other courses are being offered. Being too much of a shrinking violet and too cautious will actually be a bad thing.”

Currently, 16 universities are partnered with Coursera, which offers 124 courses in total.

Rather than using a platform like Coursera or Udacity, Krishnamurthi decided to create his course with pieces from multiple sites — using YouTube for posting videos and a tool called Piazza to run an online discussion board. He and his graduate student teaching assistant, Joe Politz, whom Krishnamurthi called the co-instructor of the online course, felt confident they could build any additional software as the course progressed, he said.

Roberto Tamassia, chair of the computer science department, said he likes to impress upon faculty members that “the teaching of an individual can have an impact on thousands of students” beyond their respective universities. Teaching an online course expands one’s influence similarly to how writing a textbook does, he said.

“Shriram (Krishnamurthi) is pretty well-known in the programming language community,” said Jason Shum ’14, a student taking CSCI 1730. “People are taking his class because they want to learn from him specifically.”

Online classes can also supplement in-person classes by providing a large amount of data for professors to analyze, Tamassia said. Tracking students’ progress in detail may help professors design better lectures and assignments.

## A LEARNING EXPERIENCE

Krishnamurthi now films his Brown classes and posts the videos online for anyone to watch. Viewers can see Krishnamurthi respond to questions from Brown students, though the students themselves are out of sight.

One of the major challenges in online learning is grading assignments, especially when course enrollment balloons. But Krishnamurthi said he likes to assess his students via open-ended questions that require essays as answers, and he did not want to water down his course for the sake of easy grading.

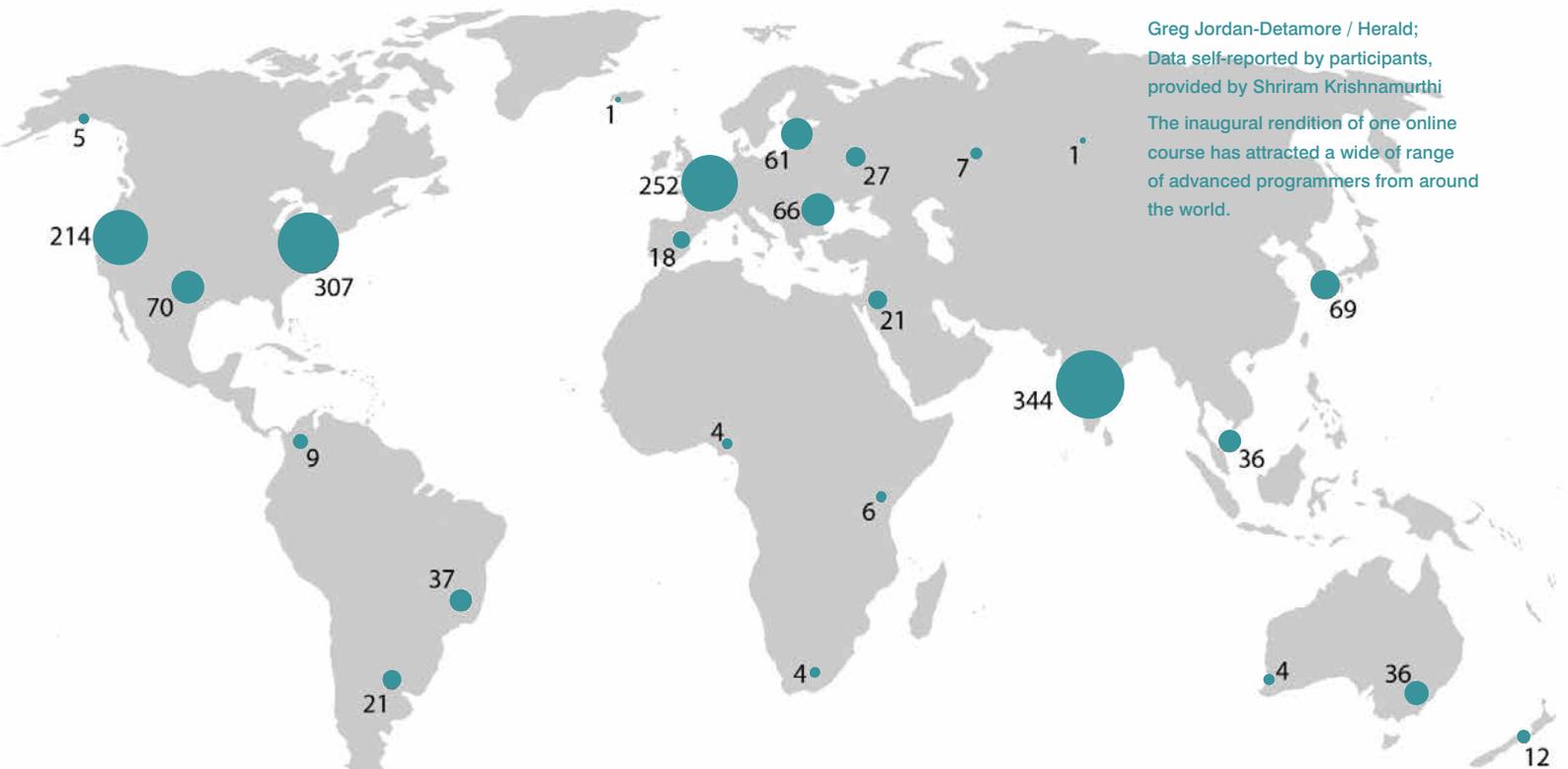
He is making all the assignments he gives to Brown students public, but online participants will only receive grades on assignments that can be computed automatically, like scores on a multiple choice quiz. The teaching assistants will run the programs that the online students submit to see if they work, but they will not actually examine the coding behind them, as they will for University students.

All students can ask questions and help each other on Piazza.

Aimee Lucido ’13, a student in the classroom version of CSCI 1730, said it is useful to have a joint forum for questions. Because so many students are in the online course, she said, “there are a lot of people who are answering questions. You’re more likely to get an answer quickly.”

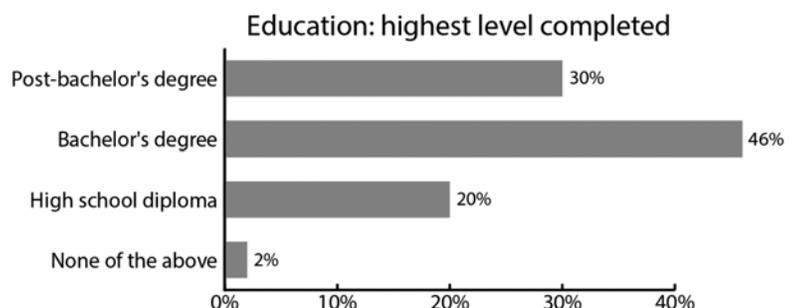
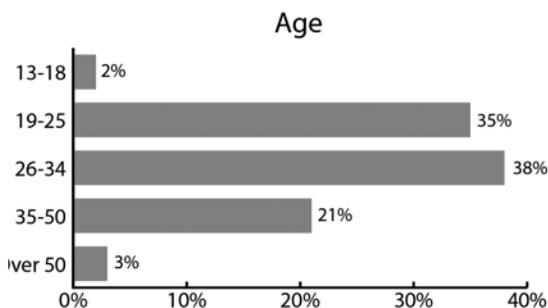
Krishnamurthi spends between three and 10 hours a week monitoring the forum, which he said is the major additional time commitment of the online course.

Though creating an online course required these changes,



## Demographics of CSCI 1730 online signups

Geographic distribution, clustered by world region



Krishnamurthi has always made his content available online for free. He said he avoids systems like Blackboard that prevent people from outside the University from accessing his course site.

For Krishnamurthi, the decision to create an online course stemmed from his desire to tackle a new challenge and learn whether he could use the web to improve his teaching, he said.

### THE BROWN ADVANTAGE

Despite the work he has put in to his online course, Krishnamurthi said he does not think online learning can match in-person classes. "There's a real value addition to being a Brown student,"

Krishnamurthi said, citing the ability to ask questions in class, attend TA office hours and receive detailed feedback on open-ended assignments.

Lucido said one of the best parts of the Brown computer science department is the TA program, which the online students cannot access.

Tamassia echoed this sentiment, saying Brown students likely get a much richer experience than those who are enrolled online.

"Are the people in India getting my course? I don't think they are," Krishnamurthi said. "A central part is being there."

# CS Reunion





ROW 1 (Left to Right)

Shriram Krishnamurthi, Aaron Myers,  
Daniel Leventhal and Spiros Eliopoulos  
Jordan Feil and Dmitriy Genzel  
Genie and John Barstow

Tess Avitabile, Nathan Partlan, Ethan  
Cecchetti, Spencer Brady and Eric Doboan  
David Laidlaw, Curran Nachbar  
Schieffelbein and Shriram Krishnamurthi

ROW 2 (Left to Right)

Ugur Çetintemel, Degin Sun and Jie Ren  
Kathy Kirman and John Shewchuk  
IPP Manager Amy Tarbox and Ugur Çetintemel

ROW 3 (Left to Right)

Justin Ardini, Andrés Douglas  
Tom Doeppner, Duy Nguyen and Xigavei Wang  
Elaine Rich, Susan Farrel, Olga Güttag and  
John Güttag  
Mark Wachsler and David Durand  
John Güttag, Carol Chomsky and  
Andy van Dam



# Alumni Update

## DILIP D'SOUZA

Some news: I have just won the Newsweek/Daily Beast/Open Hands South Asia commentary prize for my writing. They gave me the award in New York a week ago. (I just returned to Bombay).

I really wanted to tell you personally because all of you were so good to me when I was at Brown all those years ago, and again when I came for the gathering in 2004.

This is the Daily Beast report about the award: <http://is.gd/c3lQfv>

And this is their report about the award function ("superb" is somewhat over the top but I'm not complaining!): <http://is.gd/JdCrZQ>

The prize was based on these three articles that accompanied my nomination (Karthika from HarperCollins nominated me):

- Coaching classes in Kota, (Caravan April 2012): Get to the Top, <http://tinyurl.com/DDKotaClasses>
- Sachin Tendulkar adulation, (Caravan Nov 2011): Mr Tendulkar's Neighbourhood, <http://tinyurl.com/DDTendulkar>
- Health care in rural Chhattisgarh (Fountain Ink inaugural issue cover story, June 2011): "A Few Good Doctors," <http://tinyurl.com/DDPoisoning>

cheers,  
dilip.

## JIM HENDLER SCM '83/PHD '86

World Wide Web Expert Jim Hendler Named Head of Computer Science Department at Rensselaer

Professor Jim Hendler has been named the new head of the Department of Computer Science at Rensselaer Polytechnic Institute. Hendler is currently a senior constellation professor in the Tetherless World Constellation and program director of the Information Technology and Web Science (ITWS) program at Rensselaer. He will be stepping down from his leadership of the ITWS Program to assume the department head post.

"Dr. Hendler is a strong researcher, and a vital faculty leader, widely respected within Rensselaer and far beyond," said School of Science Dean Laurie Leshin. "I am delighted to announce this appointment and am certain the department will attain even greater excellence under his leadership."

Hendler joined Rensselaer in 2007 after two decades at the University of Maryland, where he served as director of the Joint Institute for Knowledge Discovery and co-director of the Maryland Information and Network Dynamics (MIND) Laboratory.

"I came to Rensselaer because it had a great computer science department with an amazing potential to become one of the new leaders in the field," said Hendler.

"With some of the superstar hires of the past few years, the excitement in our department just continues to grow," Hendler continued, pointing to Professor of Computer Science Fran Berman, Professor and Tetherless World Constellation Chair Deborah McGuinness, and James Myers, professor and director of the Computational Center for Nanotechnology Innovation. "In some of the hottest areas in computing, such as the data-, network- and Web-science fields, Rensselaer is on a roll. I am privileged to be head of such a talented group of researchers."

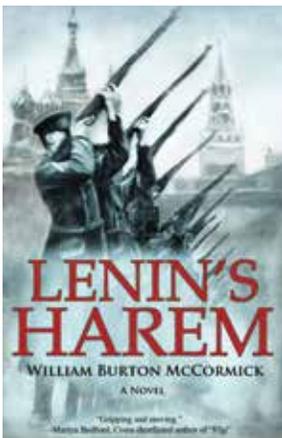
The Computer Science Department at Rensselaer is renowned nationally and internationally for its work in areas such as bioinformatics, computational science and engineering, computer vision, database systems, networking, parallel computing, pervasive computing, robotics, semantic web, software design, and theoretical computer science. The department confers B.S., M.S., and Ph.D. degrees, with enrollment currently at approximately 500 undergraduate and 100 graduate students.

Hendler's own research seeks to expand the utility of the World Wide Web. He is widely recognized as one of the inventors of the semantic web, an extension of the World Wide Web that enables computers to interpret the meaning and context of words and numbers. This technology could be used to bring informative databases — from Internet business to basic biology research — to the Web in more searchable and usable ways, according to Hendler.

Hendler received a bachelor's in computer science and artificial intelligence from Yale University, a master's in cognitive psychology and human factors engineering from Southern Methodist University, and a master's and doctorate in computer science and artificial intelligence from Brown University. He is a fellow of the American Association for Artificial Intelligence, the British Computer Society, the IEEE, and the American Association for the Advancement of Science. In 2002, Hendler was awarded a U.S. Air Force Exceptional

Civilian Service Medal. He is the first computer scientist to serve on the board of reviewing editors for *Science* and in 2010 he was named one of the 20 most innovative professors in America by *Playboy* magazine. Hendler also serves as an “Internet Web Expert” for the U.S. government, providing guidance to the Data.gov project.

### WILLIAM BURTON MCCORMICK '92



For years after graduation I worked in the interactive entertainment industry as a producer and project manager for Electronic Arts and GameTek, bringing over twenty games and several award-winning educational titles to market. For the classic gamers in you, anyone remember “Carrier Aces” from 1995? If not, you can find it on Youtube.

Later, I co-founded a company to reduce junk email with two friends including David Kopans (formerly Goldstein) '91. Our spam filter

technology won two US patents and was eventually licensed to a major email provider.

During my days in the interactive entertainment business, I would often write the dialogue scripts for the games I produced. This was something I enjoyed immensely and even after I left that business, I was often hired as a freelance scriptwriter for interactive games. In recent years, I have spent more and more of my free time writing, and I am happy to announce that my first novel “Lenin’s Harem” will be published in early December 2012. (The novel has nothing to do with a real harem by the way). You can learn more about it here:

<http://www.leninshare.com/>

I am presently in Ukraine where I am working on my next novel, a thriller set in Odessa.

All the best,

William Burton McCormick '92

### VADIM SLAVIN '02,'05

Dear Conduit, there are some significant changes in my life that I wanted to update our community on.

I am very excited to report that after 7 successful years as an accomplished research scientist at Lockheed Martin Advanced Technology Center I am leaving the company to join my co-founder full time as the General Partner of a new venture capital firm, MonthlyVentures: [www.MonthlyVentures.com](http://www.MonthlyVentures.com)

Yep, we’re doing it. Why work on one startup when we can help hundreds of dreams come to fruition in the Silicon Valley?

We founded an entrepreneurship school, StartupMonthly.org, a year and a half ago. StartupMonthly builds startup ecosystems around the world and helps young entrepreneurs get their idea off the ground. We already traveled to Russia and the Baltics and have been invited to hold our workshops and build our franchise in Colombia, Israel, Great Britain, Brazil, and Ukraine. Based on the methodology, experience, and network we have developed over this time, we were encouraged to start our own fund which we are currently in the middle of raising. It will invest in close to 100 startups in the next 4 years and our first batch of investments is already arriving for our startup accelerator program in San Francisco which we are running with over 50 of our mentors.

We have been blessed with the attention of some of the most prominent shakers in Silicon Valley who offer their guidance and wisdom. However, we are still small and are looking for help: interns, partners, investors, mentors are all welcome to join us. Especially welcome are budding entrepreneurs from my CS department who, like many of their predecessors, have put their sights on the Silicon Valley.

If anyone is interested to connect, to learn more, or to join us as an intern, please contact [vadim@startupmonthly.org](mailto:vadim@startupmonthly.org)

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## Industrial Partners Program

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

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



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### Individuals

Paul Edelman,

Edelman & Associates

Rob Khoury,

World Wide Financial

Industry Recruiting

Services, LLC (WWFIRS)

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To learn more about the IPP visit:

<http://www.cs.brown.edu/industry>



Connect with the CS Department:

Join the 'Brown University Computer Science' group on Facebook.

Brown University – Computer Science



## Ping!

Where are you and what are you doing?

Let us know what's happening in your life! New job? Received an award? Recently engaged or married? Submit your news by email [conduit@cs.brown.edu](mailto:conduit@cs.brown.edu), or by mail to:

### Conduit

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