Conduit

A RESEARCH AND ALUMNI NEWS MAGAZINE
DEPARTMENT OF COMPUTER SCIENCE
BROWN UNIVERSITY

BROWN

CSI: COMPUTER SCIENCE INVESTIGATIONS

DEPARTMENT OF COMPUTER SCIENCE, BROWN UNIVERSITY
115 WATERMAN STREET, 4TH FLOOR, PROVIDENCE, RI

CASE
FORENSICS AND COMPUTER VISION

CASE NUMBER
2006-02

LOCATION
HENRICO COUNTY, VIRGINIA

CASE HISTORY

It was late, 1 a.m. on a cool Virginia night in October, and Harry Phillips, Jr. needed to get home to the next county. The 39-year-old walked into a 7-Eleven near the Richmond airport. He asked a young man buying a cheap cigar for a ride. They got in a four-door sedan and drove away.

The car headed southeast until the fast-food restaurants and hotels disappeared and open field and subdivisions rose up in the darkness. About 1:20 a.m., the sedan pulled behind a Citgo gas station on an isolated stretch of road not far from a Nabisco cracker plant and a county par Phillips got out of the car. Gunshots rang o

ning, October 5, 2005, the owne ry Phillips Jr. dead. had been sh

Notes from the Chair: the Latest News from 115 Waterman

Greetings to All Computer Science Alumni, Supporters, and Friends!

With this fall issue of *Conduit*, I offer my sincerest congratulations to all those undergraduate and graduate students who received their degrees in our commencement exercises last May. It was a pleasure having all of you as part of the computer science "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.

Faculty and Student Accolades

The last few months have brought a number of awards and honors to our faculty and students. This past spring the Corporation approved the appointment of three computer science faculty to named professorships: Eugene Charniak, University Professor and professor of computer science; Sorin Istrail, Julie Nguyen Brown Professor in Computational and Mathematical Sciences and professor of computer science; and Ugur Cetintemel, Manning Assistant Professor and assistant professor of computer science. Congratulations to Eugene, Sorin, and Ugur!

If you haven't already seen the July/August issue of the *Brown Alumni Magazine*, please visit their web site, www.brownalumnimagazine.com, to read Lawrence Goodman's wonderful story highlighting some of our recent faculty and student accomplishments. Photographer Leah Fasten also did great work in making everyone look fantastic.

Accolades are also in order for Wenjin Zhou, a first year Ph.D. student, for receiving the first place award in the Association for Computing Machinery's (ACM) Student Research Competition at the 2006 SIGGRAPH conference; Ph.D. candidate Leonid Sigal and Professor Michael Black, for securing the best paper award at the Forth International Conference on Articulated Motion and Deformable Objects (AMDO-e 2006); and Assistant Professor Amy Greenwald, Ph.D. student Victor Naroditskiy, and undergraduate Seong Jae Le for winning the 2006 international Trading Agent Competition (TAC). Additional details about these awards, and others, can be found within this publication.

New Faculty

We are pleased to announce the appointment of Ben Rafael to the department's faculty. Ben received degrees from MIT and the University of California, San Diego, and until recently held the Alfred P. Sloan Postdoctoral Fellowship in Computational Molecular Biology at U.C. San Diego, where he worked with Pavel Pevzner. Ben will be instrumental in the growth and development of the Computational Biology Center and help to provide new direction in research and teaching within the realm of computer science. More on his background and research appears in this issue.

More New Faculty

As the department continues to grow, this academic year will find us searching for two new faculty members in the areas of computer graphics and systems. As always, we are looking for the best and the brightest to fill the positions, and we welcome your efforts to send promising candidates out way.

Alumni Outreach

I would like to thank all of our alumni and friends for their continued generosity, involvement, and support of our students and research. From attending reunions to recruiting students and graduates to contributing to our fundraising and scholarship efforts, we sincerely appreciate all of your interactions with the department. We are fortunate to have such an enthusiastic and involved community – thank you!

Finally, *Conduit* can now be called the "award winning" *Conduit* after receiving an excellence award in printing and design by the Graphic Communications Industry of Rhode Island and the Providence Chapter of the American Institute of Graphic Artists (AIGA). Congratulations to Editor-in-Chief Laura Zurowski, John deWolf of Public Information Design, and American Printing of Rumford, RI. May this be the first of many awards for our favorite publication.

Keep in touch!

Eli Upfal

Chair, Computer Science Department

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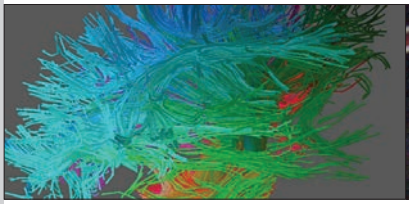


FEATURE

Conduit is printed on Burgo's ChorusArt, an acid free and elemental chlorine free paper containing 50% recycled content and 15% post consumer waste. You are the difference – reduce, reuse, recycle.

Computational Models of the Cortex

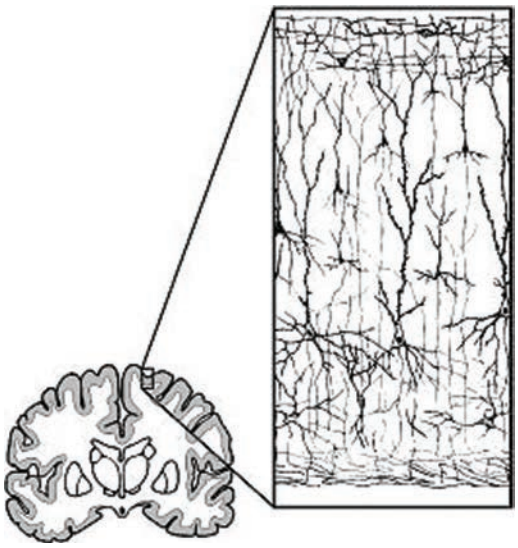
Professor **Tom Dean**'s research interests include automated temporal and spatial reasoning, planning, robotics, learning, and probabilistic inference. He is particularly interested in problems in which the notions of uncertainty and risk are complicated by the imposition of a limited time for deliberation and action.

Additional information about this project can be found at www.cs.brown.edu/people/tld/projects/cortex/.

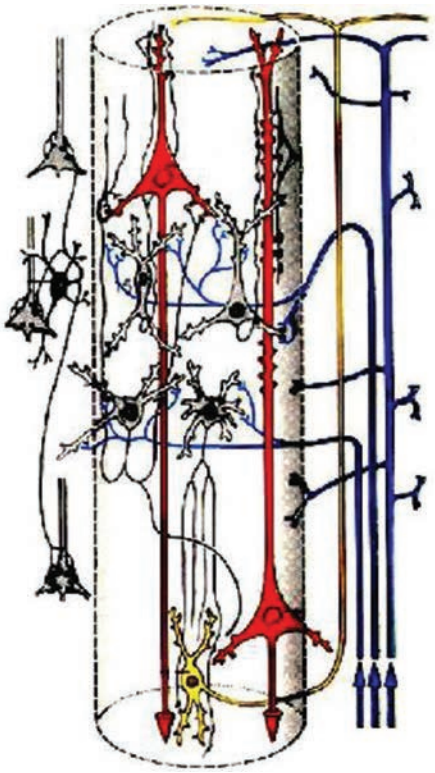
Researchers in artificial intelligence are attempting to build on recent advances in our understanding of the brain to design systems that perceive and act with human-level competence. This isn't a new trend; the prospect of artificial neural networks has fascinated computer scientists throughout the history of computing. What is new is the extraordinary detail with which we are now able probe the secrets of the brain using advanced imaging and recording devices.

The cortex is interesting in part due to the fact that the size of our cortex sets us apart from other animals. The primate cortex has a regular structure, at least when compared with other, older parts of the brain; the basic repeated structure is called a cortical column. It is as though nature stumbled on the design for a general-purpose modular memory and then mass produced it up to the limits imposed by weight and energy usage, considerations familiar to anyone designing mobile computing devices.

The cortex integrates data from different senses, different times and different resolutions, allowing us to identify correlations across time and across sensory modalities. Not only does the cortex enable us to recognize patterns in the midst of noisy backgrounds, but we can do so even if we have never encountered a given pattern at a particular scale, orientation or brightness or in the midst of partially occluding distractions. The cortex continuously predicts what we are likely to perceive next and warns us if events run counter to expectations.



Jeff Hawkins has written a very readable account of recent research in neuroscience and his own theories of the cortex. Hawkins is putting his theories to the test in a new startup named Numenta that aims to produce cortical models for applications that range from biometric identification to vehicular control. For the last year and a half, I have been working with students and colleagues at Brown and collaborators at Numenta and Google to develop systems that simulate the cortex.



Reactions to this work range from the complaint, "the very idea is ludicrous" to the more insightful question, "what is new here that might enable us to make progress on problems such as machine vision that have eluded us for decades?" My answer to the latter has two parts. First, a few companies such as Google and Microsoft now have the computational resources to model a human brain, and they also have financial incentives to develop tools that can index and search images, video and sound files as easily as we now handle text. Second, we have been studying machine and biological vision from a computational standpoint for more than half a century and the lessons learned suggest a set of key principles that can be translated into engineered systems.

There is evidence to suggest that the cortex is organized as a hierarchy of features. Features at one level are composed from combinations of features in the level below. It is no surprise that such compositional systems figure prominently in the study of natural and formal languages, industrial design, and the way in which we organize almost any kind of knowledge you can think of. Information propagates up the hierarchy as input triggers features in the

TOP RIGHT A depiction of a cortical column. The red cells are pyramidal neurons.

ABOVE A cross section of the primate brain showing the folded cortical sheet.

lower level and their output serves as the input to higher-level features. Information also propagates down the hierarchy as expectations prepare us to see what makes sense in the context of what we've already felt, seen and heard.

David Mumford at Brown and his former student, Tai Sing Lee, now at CMU, have proposed a model of the visual cortex as a hierarchical Bayesian statistical model in which recurrent feedforward and feedback loops serve to integrate top-down contextual priors and bottom-up observations. The Lee and Mumford model offers a proposal for how the cortex is organized, but not how it becomes organized; it seems likely that much of the organization of the cortex is learned. Indeed, it seems we have to be exposed to specific kinds of stimuli at particular times during our development in order to learn certain features of our environment. For example, cats raised in an environment devoid of horizontal lines will grow up unable to see or learn to see horizontal features if later exposed to a richer environment – imagine the poor cat in specially designed room with an Elizabethan collar so it can't even see itself.

"Reactions to this work range from the complaint, 'the very idea is ludicrous' to the more insightful question, 'what is new here that might enable us to make progress on problems such as machine vision that have eluded us for decades?'"

Research in machine learning makes it pretty clear that some kinds of learning are hard, unsupervised learning in particular. For instance, learning to classify objects without being shown clearly labeled training data, is devilishly hard. While it seems plausible that we learn some concepts in an unsupervised fashion, for many other learning tasks, it appears we have evolved to take advantage of environmental cues that provide a form of distal supervision. One source of such supervision comes from experiment; we learn that some foods are good to eat and others bad by tasting them. But what about learning to perceive?

Continued on page 14

Ph.D. Profiles

Stefan Roth

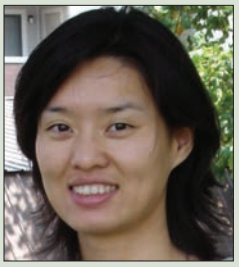
Before coming to Brown in the fall of 2001, Stefan received his degree in computer science and engineering from the University of Mannheim in Germany. At Brown he has worked with Michael Black on a number of projects in computer vision and related fields. Inspired by two internships at Intel Research in their Computational Nanovision group, he became interested in modeling the statistics of natural images and the applications of probabilistic image models to image restoration problems. Stefan's Ph.D. work also considers the problem of modeling and estimating image motion (optical flow). His paper, "On the Spatial Statistics of Optical Flow" (with Michael Black) received Honorable Mention for the Marr Prize in 2005, which is considered the most prestigious award in the area of computer vision.

Nikos Triandopoulos

Nikos, a recipient of the Department's Paris Kanellakis fellowship, received his undergraduate diploma in computer engineering and informatics at the University of Patras, Greece, and entered the Ph.D. program at Brown in 2000. His primary research areas are information security, cryptography, and algorithms. His Ph.D. thesis, titled "Efficient Data Authentication" under the supervision of Roberto Tamassia, studies theoretical and practical aspects of the problem of authenticating information in hostile and adversarial computing environments. As a member of the Center for Geometric Computing, and in a collaborative effort with IAM Technologies, Inc., he received the Technological Innovation award from Brown, and his work has led to several patent applications. For the 2006-2007 academic year, he has been awarded an I3P-funded postdoctoral fellowship, and will be working on algorithms for high assurance in cyber-security at the Institute of Security Technology Studies at Dartmouth.

Danfeng Yao

Danfeng Yao received her B.S. degree from Beijing University, China. In 2002, she started her Ph.D. studies at Brown on information security under advisor Roberto Tamassia. She has a number of publications on trust management and user privacy. Danfeng holds a provisional patent on her federated ID management work with Roberto and Professor Michael Goodrich at UC, Irvine. In 2005, she visited CERIAS at Purdue University, where she worked with Professor Mike Atallah and Elisa Bertino on multi-party computation and data integrity. In 2006, she interned in the Trusted Systems Lab at HP Labs, Princeton, NJ. At HP, Danfeng worked closely with Dr. Stuart Haber, and developed security protocols for outsourced systems that have resulted in two HP technical reports. **C!**



Rhode Maps

Professor **Philip Klein** does research in algorithms and data structures, especially in the area of combinatorial optimization, and especially those problems involving graphs.

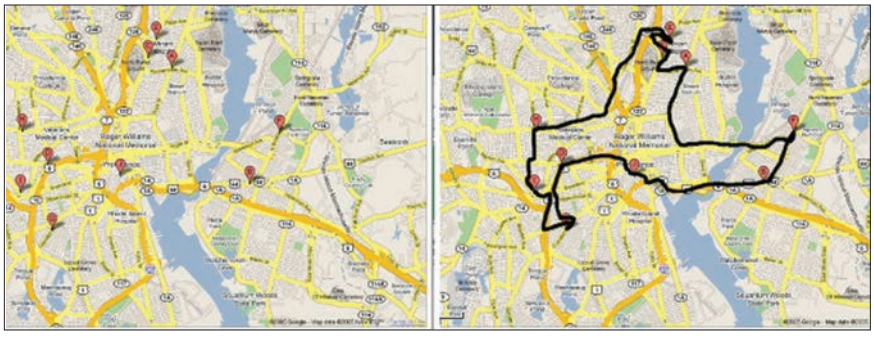
More information about Rhode Maps can be found at rhodemap.org.

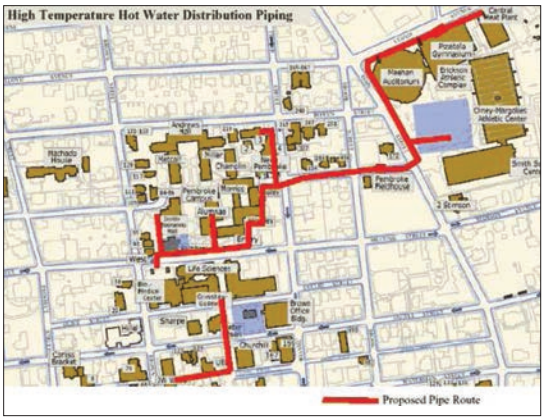
The Traveling Salesman

Imagine a truck-driver delivering soft drinks to vending machines distributed throughout the Providence area. His goal is to find a shortest route that visits all the vending machines. In principle, the best route could be found by considering all possible orderings of the locations – but that would take billions of years, even using all the computers on earth. Finding the shortest route, it turns out, is a variant of the *traveling salesman problem* (TSP), the most famous problem in combinatorial optimization. It is also famously difficult. In fact, it was one of the first problems shown to be *NP-hard*. NP-hard problems are considered theoretically intractable; theory predicts that there is no fast algorithm that finds the absolutely best solution in all cases.

How one copes with computational intractability depends on one's discipline. For a researcher in theoretical computer science, an algorithm must be accompanied by mathematically proven guarantees: a running-time guarantee (e.g. "this algorithm runs in $O(n \log n)$ for inputs of size n") and a performance guarantee. An *approximation algorithm* is an algorithm for which the performance guarantee has the form "the quality of the output of the algorithm is guaranteed to be within a factor r of the quality of the absolutely best solution." The factor r is called the *performance ratio* of the approximation algorithm.

The study of approximation algorithms as such began almost forty years ago, though growth in our understanding of what is achievable has accelerated in the past decade. Returning to our truck-driver, his problem can be viewed as an instance of a problem called *metric TSP*. The input is a table of distances between locations. (A table of distances is a specification of a mathematical structure called a *metric space* provided some simple conditions are satisfied.) The goal is to find a sequence in which to visit all locations so as to minimize the total distance traveled.





BELOW Figure 1: A set of locations. The truck-driver must travel to all these locations and wants to minimize his travel distance.

TOP RIGHT Figure 2: The proposed route for the new hot-water piping. This figure shows two disconnected networks. Each network is a Steiner tree for the sites it connects. (The problem of finding a possibly disconnected network which achieves the given connectivities is called the Steiner forest problem. The first approximation algorithm for that problem was discovered by my graduate students and me in 1991.)

Thirty years ago, Christofides discovered a polynomial-time approximation algorithm for this problem with performance ratio 1.5. That is, the algorithm is guaranteed to output a tour whose length is at most 50% worse than the best tour in existence.

One might hope for an error of less than 50%. However, for this problem nobody has found a polynomial-time algorithm with a better performance ratio than that of Christofides'. What is our truck driver to do?

Exploiting Planarity

One of the central lessons of theoretical computer science is that generality comes at a computational cost. To get an algorithm with better performance, we need to impose a restriction on the possible inputs. We start with the observation that the distances we wish to provide to the algorithm are distances between nodes in a network, namely the road map of Providence. A road map is not an arbitrary network: where two roads cross, a traveler can transition from one to another. (There are exceptions but they are rare.) The network, viewed as a graph drawn on the plane, has a property called *planarity*: no two edges cross.

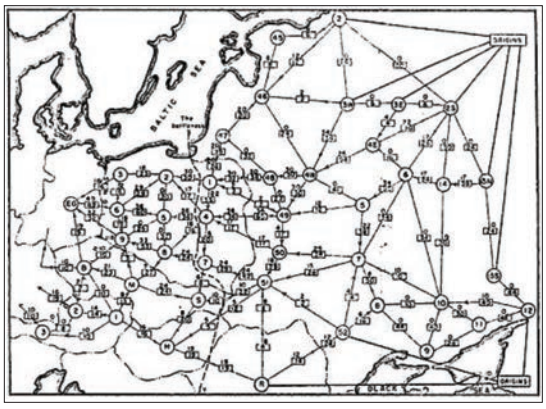
The mathematician who inaugurated graph theory in 1736, Leonhard Euler, also inaugurated the study of planar graphs when in 1750 he gave a formula relating the number of edges, vertices, and faces of a simple polyhedron. The most famous result on planar graphs is the Four-Color

"In principle, the best route could be found by considering all possible orderings of the locations – but that would take billions of years, even using all the computers on earth."

Theorem: no matter how one divides the plane into countries, four colors suffice to ensure that no two countries with a shared boundary have the same color. It was first conjectured in 1840 and not proven until 1976. Planar graphs have also played an important role in algorithms development; Hopcroft and Tarjan's work on linear-time graph algorithms, for which they were awarded the Turing award, addressed determining whether a graph was planar and, if so, finding a planar embedding (a drawing of the graph so that no two edges cross). For a taste of this task, visit planarity.net.

For the purpose of helping the truck driver, however, the important thing is that optimization problems are easier to solve on planar graphs - not that the traditional algorithms work especially well on planar graphs, but algorithms can be developed that *exploit* planarity.

Take the truck driver's problem. In a paper that appeared last spring, I showed that, for the metric space of distances between selected nodes in a planar graph, the traveling-salesman problem is easier to approximate. In particular, for every number $\varepsilon > 0$, there is an $O(n \log n)$ algorithm whose performance ratio is $1+\varepsilon$. That is, there is an approximation algorithm that produces a tour whose length is guaranteed to be at most 30% more than the true minimum, an algorithm that produces a tour of length at most 20% above minimum, and so on. There is, of course, a catch: the running time of the algorithm goes up as the desired error gets smaller. (Note: The dependence of the running time on ε is not reflected in the $O(n \log n)$ running time because ε is considered a constant in this context, and only affects the constant multiplier. It would be more precise to give the running time bound as $f(\varepsilon)\, n \log n$, where f is an (exponential) function of ε.



ABOVE Figure 3: This figure depicting the Soviet railroad network comes from a recently declassified report written by members of a U.S. think-tank in 1955.

A family of approximation algorithms, one for each ε, is called an *approximation scheme*. It's highly desirable to have an approximation scheme for a problem because it allows you to choose the algorithm that best suits your computational needs: if you have more computational power, you can get a better solution. Unfortunately, approximation schemes do not exist for all optimization problems. For example, for the traveling salesman problem for graphs that are not necessarily planar, there is no approximation scheme (assuming $P \neq NP$). Thus restricting the input to planar graphs is a big help.

Previous research had addressed the Euclidean case – where the distance between two locations is measured as the crow flies – but such distances don't accurately reflect the limitations of true road networks (not to mention the impact of rivers).

Exploiting Planarity for Other Optimization Problems

Claire Kenyon and Ph.D. student Glencora Borradaile are working with me to use a similar approach to obtain approximation schemes for other optimization problems in planar graphs. Recently we obtained an $O(n \log n)$ approximation scheme for the *Steiner tree problem* in planar graphs. I'll illustrate this problem with a current project at Brown University, putting in high-temperature hot-water pipes. Various sites around campus must be connected with underground pipes. The pipes are (mostly) routed along roads, as you can see in Figure 2 (preceding page). Consider the optimization problem of finding the routing that connects the sites so as to minimize the total length of the trenches that must be dug. This problem is a Steiner tree problem in a planar graph (the road map).

Planarity is useful even in addressing problems for which polynomial-time algorithms are known. Another fundamental optimization problem is

Continued on page 14

Simulation Philosophies: Researching, Teaching, and Learning in a Post-Linear World

Clark Bennett Aldrich '89 is the author of several books including *Learning by Doing: The Essential Guide to Simulations, Computer Games, and Pedagogy in E-Learning and Other Educational Experiences* (Wiley, 2005). Clark's "SIM Word of the Day" can be read online at learningcircuits.blogspot.com.

Computer Game and Simulation Design as Horizontal, not Vertical, Activity

Universities are teaching courses on computer game design at both the undergrad and graduate levels. And increasingly, courses are also focused on not just commercial games but educational games as well.

Just to name a few: Deakin University in Melbourne Australia runs a unit on "Playful Learning Environments." Columbia University's Teachers College has a course in games and education. The Minneapolis College of Art and Design has an Edutainment program. Danube University in Krems, Austria, where post-graduate teacher education is their core business, has a Game Studies Course in their Masters Program in Educational Technology and Educational Leadership, as well as various seminar type courses outside of their master programs.

"Situational awareness is the ability to filter out certain details and highlight and extrapolate others, to better understand and control the outcome."

But the next breakthrough will be when simulation and game design is not taught as a vertical skill, like Russian History, Clinical Psychology, or Biblical Archeology, but a horizontal skill, like researching, analysis, writing, and public speaking.

The philosophies of simulation design permit different types of knowledge-capture to augment linear approaches such as writing, taking pictures, and making films. And the full assimilation of post-linear content will change every aspect of universities, from research agendas, to which will be the most influential, to the critical issues of what is taught, how, and why.

There are at least four major constructs – situational awareness, understanding of actions, awareness of patterns over time, and conceptual dead reckoning – that are as natural to simulations as internal monologues and narratives are to books.

Situational Awareness

What do people at the top of their game see when they encounter a situation that others do not?

For example:

- What did George Washington see as he walked down colonial Boston that was different than the majority?
- What did Louisa May Alcott see when her house was filled with people?
- What did President Carter see when he looked at a map of the world in 1978?

Situational awareness is the ability to filter out certain details and highlight and extrapolate others, to better understand and control the outcome. Different people with different domain expertise bring different situational awareness to the same situation.

Understanding of Actions

What do leaders view as viable things to do?

For example:

- Before and during the battles of America's Revolutionary War, what were the ten or fifteen options that General George Washington repeatedly considered? What sequence did he do each time, and with what relative intensity?
- Every week, what group of discretionary actions did Joseph Stalin consider while in power? Of those choices, which did he take? How did those actions (both considered and taken) shift over his years in power?
- What options did the Ottoman Empire have to deal with its neighbors?

This so-called "cyclical content" identifies the activities that can be infinitely and repeatedly combined to create often wildly divergent outcomes. They are bundles of discrete action, timing, and magnitude that are a natural concept to us when understanding how to operate a machine like a car, use a typewriter, or even perform with a piano. The opportunity, however, is to move beyond these kinesthetic examples to create, through the mapping of actions, cyclical content for better understanding cultural literacy as well as hard skills.

Continued on page 15

SIGGRAPH 2006 Boston

Computer Graphics Group

The Department held two alumni reunions in conjunction with SIGGRAPH 2006. The first, a dinner held at Bertucci's Brick Oven Ristorante in Boston, was attended by some sixty-five former students as well as current members of the Graphics Group (plus a handful of friends and spouses).

The second reunion event, held a few days later, started with an open house in the Computer Science Department and at the Cave; it included demonstrations and poster presentations of current research. Afterwards, the attendees moved to Andy's house for an informal barbeque. Despite the gray skies, everyone had a great time eating, drinking, and socializing.

The entire conference program can be viewed online at www.siggraph.org/s2006. **C!**

TOP LEFT Ph.D. candidate Liz Marai presents a demo as part of the Department's SIGGRAPH 2006 open house.
TOP RIGHT The reunion dinner is always a popular event for current and former Graphics Group members.
BOTTOM The weather started off gray and chilly but cleared up just in time for the merriment at Andy van Dam's post-SIGGRAPH barbeque (although only the hardiest of souls ventured into the water).

Posters, Papers, and Sketches Presented at SIGGRAPH 2006

Papers

SmoothSketch: 3D Free-form Shapes From Complex Sketches Olga Karpenko and John F. Hughes

The Graphics Teaching Tool Anne Morgan Spalter and Dana K. Tenneson (Anne wrote the paper and Dana gave the talk as part of the Educators Program)

Course

An Introduction to Sketch-Based Interfaces Randall Davis and Takeo Igarashi, organized by Joseph LaViola

Sketches

Extracting Boolean Isosurfaces From Tetrahedral Meshes Gabriel Taubin and Peter Sibley,

World-Space Servoing for Character Animation Under Simulation Pawel Wrotek, Chad Jenkins and Morgan McGuire

Implementation Details of SmoothSketch: 3D Free-form Shapes from Complex Sketches Olga Karpenko and John F. Hughes

Posters

Perceptual Coloring and 2D Sketching for Segmentation of Neural Pathways Wenjin Zhou, Peter G. Sibley, Song Zhang, David F. Tate, and David H. Laidlaw. * Winner of the ACM Student Research Competition.

Interactive Layered Character Animation in Immersive Virtual Environments Mykhaylo Kostandov, Radu Jianu, Wenjin Zhou, and Tomer Moscovich

Multi-Flash 3D Photography: Capturing Shape and Appearance Douglas R. Lanman, Peter G. Sibley, Daniel Crispell, Yong Zhao, and Gabriel Taubin

CaveWriting 2006: A Hypertext Authoring System in Virtual Reality Damon Baker, Sascha Becker (Laszlo Systems Inc.), Robert Coover, Ilya Kreymer, and Nicholas Musurca

Poisson Image Editing Extended Daniel Leventhal, Bernard Gordon, and Peter G. Sibley

Restricted Coloring Using Saliency-Based Image Segmentation Marc ten Bosch and Seong Jae Lee

CSI: COMPUTER SCIENCE INVESTIGATIONS

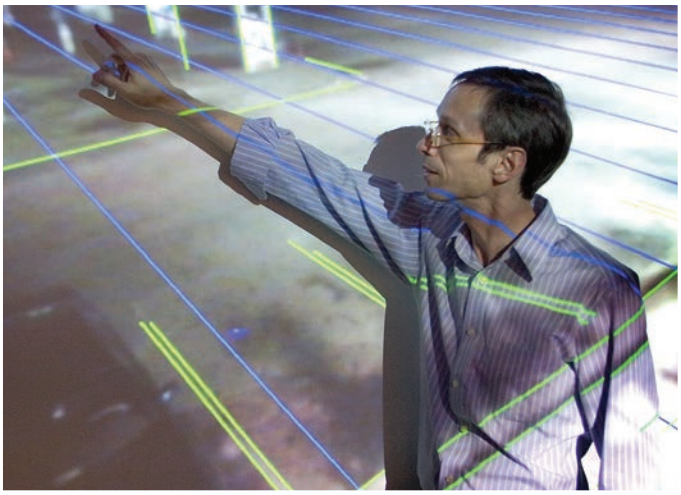
FEATURE ARTICLE
FORENSICS AND COMPUTER VISION
AUTHOR: WENDY LAWTON

CASE HISTORY

It was late, 1 a.m. on a cool Virginia night in October, and Harry Phillips, Jr. needed to get home to the next county. The 39-year-old walked into a 7-Eleven near the Richmond airport. He asked a young man buying a cheap cigar for a ride. They got in a four-door sedan and drove away.

The car headed southeast until the fast-food restaurants and hotels disappeared and open fields and subdivisions rose up in the darkness. About 1:20 a.m., the sedan pulled behind a Citgo gas station on an isolated stretch of road not far from a Nabisco cracker plant and a county park. Phillips got out of the car. Gunshots rang out.

The next morning, October 5, 2005, the owner of the gas station found Harry Phillips Jr. dead. Phillips, former petty thief and father, had been shot three times from behind. His wallet was gone.



Michael Black is a professor of computer science and a computer vision researcher. Scientists working in computer vision try and get machines to interpret real-world images with the clarity that humans do. Or in the case of forensic computer vision, they try and get machines to extract visual information that humans can't get to.

The work requires an extensive knowledge of optics as well as a strong grasp of statistics, geometry and mathematical computing. Black is a leader in the field.

In January, Black got an email from a colleague at the University of Minnesota. A police detective from Henrico County, Virginia needs help solving a murder. The best evidence in the case is video shot by two security cameras – one mounted inside a convenience store, the other outside a gas station. The footage shows the victim, a suspect and the suspect's car. The images, however, are a disaster. They are distorted, speckled, blurred. Some are plagued by shadows, others by glare. The quality is so poor, the suspect's features are barely distinguishable. The color of the car and the license plate number is a mystery, the make and model are, too. Was Black interested?

As a scientist, Black was tempted by the technical challenge. As a teacher, Black was enticed by the learning opportunity. He could show students how to work through a difficult problem as a team. "Crime shows make it look easy," Black said. "But I knew that extracting anything useful from these videos would require machine vision methods at or beyond the current state of the art."

Wendy Lawton is a senior science writer in the Office of Media Relations. Professor **Michael Black**'s research lies at the intersection of computer science and the physical world in which machines must interact with, and adapt to, a complex, dynamic, and partially observable environment.

On the first day of Topics in Computer Vision this spring, Black announced to the 16 graduate and undergraduate students gathered that they'd be helping to solve a murder case. He described the crime, the video, and the goal: determine the make and model of the suspect's car. Excitement rippled through the room.

Several students, however, suspected a hoax. Computer vision students are used to "toy" problems, the kind that neatly illustrate a concept or a problem-solving method but lack real-world complexity. So a true-crime test? "It seemed crazy," said graduate student Eric Rachlin. "Solving a murder mystery in class? C'mon."

The deal, however, was real. Proof arrived in a priority package: the surveillance tape from the Citgo station that showed the car pulling in prior to the shooting. One student dismissed the video as "comically blurred." But the class broke into teams. And to clean up the images, they tried just about everything.

They used statistical modeling and Markov random fields to remove tiny lines and other visual "noise." They tried deinterlacing, a technique used to tease apart television images and sharpen their appearance. They used deghosting, a method of removing image doubles or "ghosts." Motion estimation, super-resolution, specularity detection, 3D tracking, camera calibration – students tried them all. Some techniques yielded good results. Others didn't; there simply wasn't enough data to unlock the mysteries inside the pixels.

The students, and their professor, pressed on. They asked police to send measurements of the gas pumps, parking lot lines, and other critical objects in the video scenes. One grad student, Matt Loper, had his parents drive over an hour from their Virginia home to photograph the gas station. Another grad student, Matt Leotta, walked around campus taking shots of Toyotas and Nissans – likely makes of the suspect's car – so that he could superimpose them onto the surveillance video for comparison.

"I've never taught such a motivated class," Black said. "I think we were all a little obsessed with solving this murder."

Andrew Stromberg, an investigator with the Henrico County Division of Police, flew to Providence for an April briefing. Afterward, Stromberg sent the 7-Eleven video that showed the suspect and the victim together. Could the class get any identifying details about the suspect? Students, who'd spent

EXERCISING GHOSTS

AUTHOR: MICHAEL BLACK

CASE HISTORY

We've probably all been annoyed by "ghost" images on our TV sets, particularly when using an antenna. Ghosts are like a visual echo--they occur when an image if formed from multiple time-delayed copies of a signal. Ghosts can occur in a security camera setup when the image being transmitted from the camera to the recorder is "reflected" at one of the connectors. The image travels back up the cable, is reflected back again, and this repeats with the reflected signal getting weaker each time. The image that is recorded contains the original signal plus these "ghost" copies. Because a video image is produced from left to right, and each reflected ghost image is delayed by the time it takes for the signal to bounce back and forth, the ghosts appear spatially shifted to the right (Figure 1 left).

To remove ghosts, computer science Ph.D. student Eric Rachlin estimated the spatial shift of the signals and the decay of the signal with each reflection. Knowing that the final image was the sum of all these reflected signals he was able to subtract the ghosts to produce a sharper image (Figure 1 right). These enhanced images are being used by a police sketch artist to produce a new drawing of the suspect (who appears in dark clothing in the video).

ABOVE Figure 1: To remove ghosts, computer science Ph.D. student Eric Rachlin estimated the spatial shift of the signals and the decay of the signal with each reflection.

hundreds of hours on the project, worked past the last day of classes and into Reading Period. In the middle of finals week, Stromberg and his partner, Charles Hanna, flew up to get their answers.In a darkened classroom, the computer scientists and the cops met over coffee and doughnuts. As students made their presentation, it was clear. Mathematical prowess and meticulous work had paid off.

A computer program custom-made by grad student Alexandru Balan helped the class calibrate the wheelbase of the suspect's car. That key piece of data, coupled with telling details like headlight shape, body contour, and license plate position, led the class to a strong conclusion. The car is a Toyota Camry. It was made in 1992, 1993, or 1994. It has a sunroof wrapped in a wind deflector.

Using the convenience store tape, the class sharpened images to better reveal the suspect's face. In a clever turn, students used calibration techniques and measurements from the doorway, counter, and other fixed objects in the convenience story to create a "virtual pole" that allowed them to gauge the suspect's height with a strong degree of certainty. The killer was five feet six or five feet seven.

Police plugged the vehicle information into a state database. There were 76,000 '92-'94 Toyota Camrys registered in Virginia. Add in the sunroof and likely paint color possibilities and that number dropped to about 600 cars. Sharper images of the suspect's face and a new height estimate were turned over to the county's police sketch artist.

"I'm pretty impressed," Stromberg said. "These students went above and beyond and came up with good information that gives us a lot of direction. We've got something where we had nothing. Eventually, this guy is going to get caught."

In the meantime, the cops are nominating the computer scientists for commendations. The awards are the highest civilians can receive from county police.

"It would be great to get a plaque," Rachlin said. "But I think everyone, at this point, just wants this guy caught." **C!**

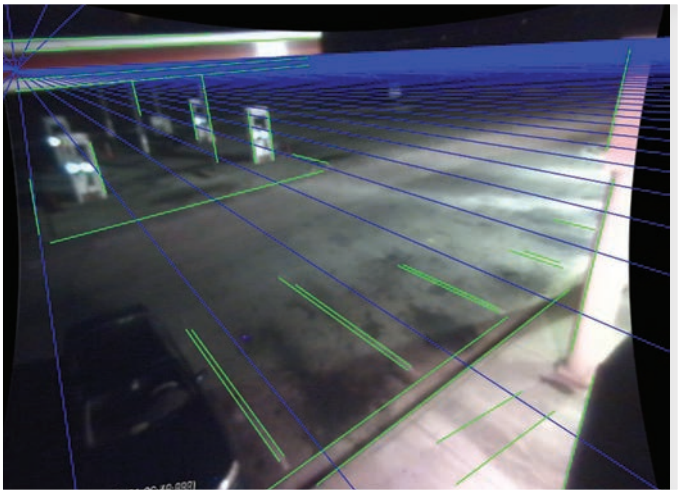
TOP Professor Michael Black works with graduate students to decipher the crime scene video. **BOTTOM** (left to right) Michael Black, Matthew Loper, Eric Rachlin, and Matthew Leotta form a "line-up" in front of an image from the convenience store.

Photos: John Abromowski

Participants in this project included:

Michael J. Black (professor)
Alexandru Balan
Marc Ten Bosch
Daniel Crispell
Ethan Leland
Matthew Leotta
Matthew Loper
Teodor Mihai Moldovan
Mark Moseley
Eric Rachlin
Ethan Schreiber
Theresa Vu
Matthew Wronka
Pawel Wrotek
Peter Yee
and:
Annabelle and George Loper
(Matt's Parents)

TOP Figure 2.1: A frame from the original surveillance video.
MIDDLE Figure 2.2: Establishing the camera parameters satisfied the observed perspective projection (Matthew Loper).
BOTTOM Figure 2.3: 3D model of the scene (Matthew Leotta).
BOTTOM RIGHT Figure 2.4: Accurately computing the wheelbase (Alexandru Balan).

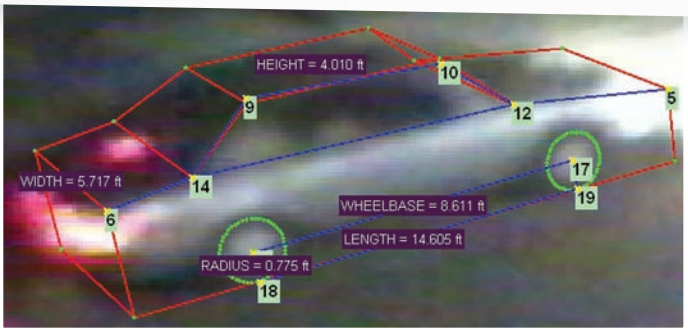


PUTTING THINGS IN PERSPECTIVE

AUTHOR: MICHAEL BLACK

CASE HISTORY

Brown was initially contacted when the police were unable to identify the suspect's car captured in surveillance video due to poor resolution, lighting and image quality (Figure 2.1). To identify the car, accurate measurements were needed of the wheelbase and other properties. Extracting such three-dimensional (3D) information from a two-dimensional image first requires calibrating the camera to estimate its location and orientation in the world as well as its internal parameters (focal length, radial distortion, etc.). Without access to the camera, the class computed this calibration from lines in the image. Curved lines in the image that were known to be straight in the scene were used to estimate the radial distortion. Perspective projection tells us that parallel lines in the scene are known to intersect at a vanishing point. Using multiple sets of parallel lines of different orientations the students were able to mathematically solve for the camera parameters satisfying the observed perspective projection (Figure 2.2). This enabled them to build a 3D model of the scene (Figure 2.3) and to track the motion of the car along the ground. Estimates of the wheel centers in multiple video frames were then combined with the camera calibration to accurately compute the wheelbase of the vehicle at 103" (Figure 2.4). When combined with other features and measurements of the car, the class was able to identify the mostly likely vehicle as a 1992-1994 Toyota Camry.



Computational Models of the Cortex
Continued from page 5

How do we learn the hierarchy of features that enables us find our way in the woods, recognize faces, and pick out a house or car from a photo?

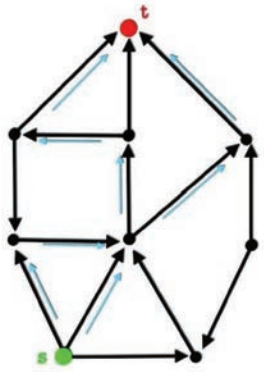
One form of distal supervision that we take advantage of in our model arises from the observation that sensory input tends to vary quickly while the environmental features we wish to learn change more slowly. Consider, for example, when you look at an object. The object remains in view for some time; perhaps the object remains fixed while you move around it or you remain fixed while the object moves. What is important is that the object remains constant while we observe it from different angles, different scales, and different lighting conditions. The learner is given a sequence of images, think of them as frames in a movie, and we assume that they are of the same object; the frames are not explicitly labeled, but frames that are close together in time tend to have the same label. This basic idea can be applied to learning all sorts of things. For example, by exploiting the fact that topics don't change quickly in a story, we can learn to categorize documents and web pages into meaningful classes.

I'll close by mentioning a few of the Brown connections that have come up in pursuing this work. Last winter I worked at Numenta helping to develop the underlying mathematics for their models. Numenta is in startup mode and currently has less than a dozen engineers, but one of them, Charlie Curry ('00), is a former student and another, Frank Astier, worked with Pascal at ILOG. This fall I'll be working with a team at Google implementing a version of our model to run on Google's massive clusters. At Google, I've run into dozens of former students, including three former Artemis coordinators, Sarah Bell, Christine Davis, and Susannah Raub. Peter Norvig ('78), the Director of Research at Google, invited me to spend my sabbatical at Google, and Glenn Carroll who did his Ph.D. work with Eugene is one of the researchers I'll be working with. Finally, it is worth noting that several Brown faculty including Elie Bienenstock, Michael Black, Stu Geman, Ulf Grenander, David Mumford, and Mayank Mehta have made fundamental contributions to the research that my work is based on. **C!**

Rhode Maps
Continued from page 7

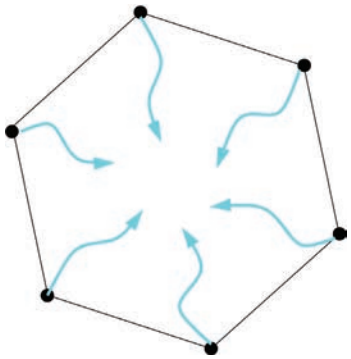
called *maximum st-flow*. Given a network in which each link has an assigned *capacity*, and given a pair *s*, *t* of nodes, the goal is to find a way to route a maximum amount of some commodity along the links from *s* to *t* without exceeding the link capacities. It turns out that finding a maximum *st*-flow enables you to also identify a minimum *st*-cut,
i.e. the bottleneck set of links that prevents you from sending any additional amount.

The study of max-flow and min-cut originated in a secret 1955 U. S. report (declassified six years ago) addressing the Soviet railway system. (See Figure 3 on page 7) The goal seems to have been to find the best way to cut the network. The minimum-cut problem arises in numerous application areas, including image processing. There are algorithms to find a maximum *st*-flow and minimum *st*-cut in general networks, but every one requires time that grows at least quadratically in the size of the network. Fifty years ago, Ford and Fulkerson (the first to write publicly about max flow) gave a planarity-exploiting algorithm that worked in a very special case, the case in which *s* and *t* both appear on the outer boundary of the planar graph. (See Figure 4.) Since that time there has been a series of results on max flow in planar graphs. Last January, Glencora Borradaile and I presented the first correct $O(n \log n)$ algorithm for max *st*-flow in directed planar graphs.



ABOVE Figure 4: Shows a maximum flow.

Another fundamental polynomial-time solvable problem in optimization is shortest paths. Given a graph with nonnegative edge-lengths and a start-node *s*, the goal is to compute the shortest paths from *s* to all other nodes. There is an $O(n \log n)$ algorithm that does not exploit planarity. (Note: There is in fact a linear-time planarity-exploiting algorithm for this.) However, using a planarity-exploiting algorithm, one can in $O(n \log n)$ compute shortest paths from all nodes on the boundary of the planar graph to all other nodes. (See Figure 5) This algorithm is an important ingredient in several recent algorithms, including the $O(n \log n)$ approximation scheme for the truck-driver problem (the planar TSP problem described earlier).



ABOVE Figure 5: For about the cost of computing shortest paths from a single node, one can compute shortest paths from all nodes on the boundary of a planar graph.

Theoretical Algorithms Research

The new algorithms have been formulated mathematically, but have not yet been implemented to run on a computer. Theoretical computer science enables a researcher to formulate an algorithm

and analyze it to predict whether it will perform well. This approach saves work because only algorithms that are justified by theoretical analysis need to go through the long process of implementation and comprehensive testing. However,

Simulation Philosophies
Continued from page 8

Awareness of Patterns

What are the three or four factors that a leader most cares about? What impacts these variables, the underlying systems, and how do they play out?

For example:

- What were Albert Einstein's highest priorities during any given year? How were those measured, and what changed them? How were his activities divided between them?
- How about Marquis de Lafayette?
- Or the government of Saigon from 1954 to 1975?

Ironically, sometimes a drop in one results in the increase of another. For a leader, a foreign attack (decrease in national security) can boost domestic popularity. Or a population explosion of an animal can lead to starvation and population decimation. Crisis of faith can lead to new approaches to solving problems.

First understanding and then taking advantage of these patterns defines most of history's successes, political and intellectual.

Conceptual Dead Reckoning

When hiking, one can get lost. So it is rather nice when someone pulls out the map, takes out the compass, does some internal calculations, and points in a direction. "That's the way," the person says, and before nightfall, having hiked through winding trails, everyone is at the new site.

To understand the behavior of people in challenging situations, it is critical to understand first what is the conceptual map that the leaders see, and what is their strategy for identifying a destination.

Conceptual maps, complete with large dark spots labeled "unknown," can include:

- Differing governing models for a new nation.
- Different combinations of chemicals and therapy that may cure Parkinson's.
- Differing drama genres for conveying a complex idea.

Then, once the maps are roughed out, leaders commit to a destination, create a vector based on understanding of current and destination location, and finally make a series of short term decisions based on reconciling the vector against real options available on a map.

Beyond Word: Assignments in PowerPoint and Excel

Seeing the world through the approximation of a simulation rather than a book ultimately will require new tools and even a new syntax and corresponding style guide. Simulations will be seen as a "computational science" tool for learning, just as an electron microscope and NMR are for microbiology. It allows us to see the world at a new level of resolution as well as "in vivo" with the learner interacting with the learning material, and we've never had this much insight available.

But it is amazing how quickly we can use some common tools to begin the transformation. For example, spreadsheet programs can model many interesting systems that produce relevant historical patterns. Meanwhile graphical programs including PowerPoint can mock up both views of the world and even visualizations of viable options. In all cases, computer games present inspirational, if imperfect, models.

The double-edged sword of writing is that it is vague (or discursive), requiring the mind to fill in many of the cracks. The double-edged sword of educational simulations is that they are not. Ultimately it is the combination of the two that will define formal learning in this decade and beyond. **C!**

C! Comments?

Send your views to: Conduit,
Department of Computer Science,
Brown University, Box 1910,
Providence, RI 02912
or email conduit@cs.brown.edu

Michael Black

In the spring Michael attended the European Conference on Computer Vision in Graz, Austria where he and Ph.D. student, Stefan Roth, presented a paper on Bayesian inference in high-order graphical models.

June brought the annual IEEE Conference on Computer Vision and Pattern Recognition which was held in New York City. Three of his students, Stefan Roth, Alexandru Balan, and Leonid Sigal, had papers accepted this year. The highlight of the trip was a meal at Per Se which Michael ranks as the best, and most expensive, of his life.

From New York, Michael flew to Santorini, Greece, to attend AREADNE 2006, a workshop on research in encoding and decoding of neural ensembles. It was a superb meeting in a spectacular location.

Michael spent part of the summer living in Stockholm, Sweden and working with colleagues at KTH (The Royal Institute of Technology). In August Michael attended the Gordon Conference on Sensory Coding in the Natural Environment in Big Sky, Montana, where he gave an invited talk showing how standard receptive field models of early visual processing in the brain can be explained by random filters. During one of the midday breaks, Michael scaled the 11,166 foot peak (see below) during a grueling four hour trek in thin air.

Along with Chad Jenkins and John Donoghue in Neuroscience, Michael received a $314,880 infrastructure grant from the Office of Naval Research to support the purchase of motion capture equipment and a robotic hand.

Ugur Cetintemel

In April, Ugur organized the Networking Meets Databases (NetDB'06) workshop with John Jannotti. The goal of the workshop was to bring together networking and database researchers and it attracted over forty attendees from both communities – quite a success.

In June, Ugur attended SIGMOD, with Ph.D. students Yanif Ahmad and Olga Papaemmanouil, where he was the co-author of a regular paper and a demo paper. In September, Ugur traveled to Seoul for the Very Large Data Bases Conference (VLDB) with Ph.D. students Jeong-Hyon Hwang and Nesime Tatbul, and post-doctoral researcher JeHyok Ryu. In addition to presenting papers and attending the technical sessions, they ate lots of kimchi and bulgogi and enjoyed traditional Korean music and dance.

Amy Greenwald

Amy Greenwald is currently on sabbatical and awaiting the publication of the book she co-authored on the International Trading Agent Competition, an annual event in which she has participated since its inception in 2000. In TAC-2000, RoxyBot, Amy's trading agent, was one of the top-scorers, but in the ensuing years she struggled to design an agent with a better strategy. This past year she finally succeeded. RoxyBot-2006, built by Amy and her students, Ph.D. candidate Victor Naroditskiy and undergraduate Seong Jae Lee '07, snatched a first place victory from the jaws of Michigan's Wslverine in TAC-06. Seong Jae will describe the workings of RoxyBot-06 at IJCAI-07 in Hyderabad, India in January.

Amy also presented a tutorial at ACM's Electronic Commerce conference, and gave talks at MIT and Harvard, all on the subject matter of her book.

John Hughes

Spike will teach CS4 this spring, since Alan Usas of CIS, who's taught it for the last several years, will not be able to. Spike plans to teach a primarily-Matlab-oriented course (but still include some "C"). If you have ideas for good real-world motivating examples suitable for people who may have no prior programming background, please let him know.

Spike also participated in the SIGGRAPH "fast forward" presentation (that's a 50-second research paper summary the night before the session begins). Other highlights of SIGGRAPH include: Shree Nayar's presentation on catadioptric imaging, the Brown reunion dinner, and talking with Andrew Kass about topics such as, "Why do fish, far from the ocean floor, tend to swim upstream?"

John Jannotti

John received his first outside funding recently, in the form of two grants from the NSF. The first, "Safe at Any Speed," aims to rethink the way highly-concurrent server applications are built. The project argues that concurrency in servers can be safe-by-default. Today, independent threads are unsafe-by-default, and must be manually synchronized with error-prone locks. A better approach is to automatically detect potential conflicts at compile-time and protect against them. Developers could be assured their application is correct and would only spend time understanding its concurrent interactions if they needed to improve performance.

The second grant, with Anna Lysyanskaya, aims to reconcile accountability with anonymity in peer-to-peer systems. Peer-to-peer systems have received a lot of attention in recent years because of their scalability and decentralized fault-tolerance. By their nature, peer-to-peer systems lend users a degree of anonymity, and some consider true anonymity to be a design goal. Unfortunately, since peer-to-peer systems draw their power from the contributions of nearly anonymous users, it is quite difficult to ensure these users contribute in proportion to their demands. John and Anna hope to use e-cash to maintain proper accounting, while ensuring the anonymity of participants.

Chad Jenkins

Chad and the CS148 course staff are pleased to introduce "Roomba Pac-Man" to students enrolled in robotics this fall. Using Roomba robotic vacuums donated by iRobot Corp., students will program the Roombas to play Pac-Man on the 5th floor of the CIT.

Thanks to Harmonix's *Guitar Hero* game, Chad's 3-year old daughter, Morgan, can now sing "Iron Man" and "Smoke on the Water" on request.

Claire Kenyon

Suppose that you're running a chess tournament in which everyone plays everybody else, and you want to rank the

players. Ideally, if Alice beats Bob and Bob beats Charlie, then one would expect Alice to beat Charlie. Unfortunately, the real world is not that predictable, so there will be some cycles in the graph of who beats whom. How can we design a ranking that is as consistent as possible with the data we collected? One measure of inconsistency is the number of pairs of players where the loser of the game ends up being ranked higher than the winner. (In technical terms, this is called the Minimum Feedback Arc Set in Tournaments.)

The problem is NP-hard, hence widely believed to be impossible to solve efficiently. Together with graduate student Warren Schudy, Claire designed an approximation algorithm with few inconsistencies. Given a desired accuracy such as 1%, the algorithm finds a ranking with at most 1% more inconsistencies than the minimum possible. The algorithm also extends to combining results provided by search engines into a single global ranking that is as consistent as possible with the individual rankings. This was the accidental outcome of Warren's "reading and research" project with Claire: the original goal was to study correlation clustering problems, but one of the papers they read also happened to deal with tournament ranking, which turned out to be less resistant to theoretical attacks. The project also went overtime and was completed via frantic email exchanges while Claire was in France during the summer, leading up to a 4:30 p.m. conference submission to meet a 5 p.m. deadline.

Philip Klein

Klein continues to work on algorithms for optimization problems in planar graphs (see article on page 6) and was recently awarded an NSF grant to continue this research. During the past academic year, his work appeared at the IEEE Symposium on Foundations of Computer Science, the ACM-SIAM Symposium on Discrete Algorithms (coauthored with Glencora Borradaile), and the ACM Symposium on Theory of Computing. Another result, coauthored with Claire Kenyon and Glencora Borradaile, has been accepted to the upcoming Symposium on Discrete Algorithms.

Klein has also been serving as the head of the Department's master's degree program. He welcomes inquires from alums and others who might consider returning to enhance their skills, delve into research, or just rediscover the joy of computer science.

Shriram Krishnamurthi

Shriram's forays into computer security have been successful, with three papers over the past year and an NSF CyberTrust grant. He has begun two exciting new projects, one on policy-informed program analysis and another on a new programming language, Flapjax. He hopes to report on these in upcoming *Conduit* articles.

Since mid-March he has been in five different countries and four different states. He visited Japan for the first time, attending a conference (where student Greg Cooper gave an outstanding talk) near the foothills of Fujisan. The photo at left is of the Koyasu-no-to pagoda in the Otowasan Kiyomizu-dera complex in Kyoto, Japan.

Shriram will be on sabbatical for 2006-07 and will spend September and October in Providence, November at the University of Edinburgh, December visiting India, January in Australia, and the spring at University of Texas, Austin, and other places. He wants to drink his java from an old tin can while the moon comes shinin' high; he wants to hear the call of a whippoorwill; he wants to hear a coyote whine. He wants to be alone, he wants to be back home -- out on the Texas plains. (Thanks, Hank Snow.)

David Laidlaw and Barbara Meier

David, Professor Barbara Meier, and their two children traveled to Ireland this past summer for a two-week car and bicycle tour – the trip was quite an adventure (see photo below).

David and Barbara also attended SIGGRAPH as did many of David's research group. Wenjin Zhou, who has just completed her first year as a graduate student, won first place in SIGGRAPH's student research competition. We are very pleased with this accomplishment!

Barbara is gearing up for her new computer animation course, a follow-up to her introductory course, which will be taught in the spring. She welcomes any Brown alums working in animation to come give a guest lecture.

David and his group continue to attend and publish at a number of conferences related to visualization, biology, medical imaging, and bioengineering. In addition to studying brains, bats, and bioflows, they are starting to look at visualization of gene regulation networks and protein signaling networks. This exciting and challenging new area is connecting them with new collaborators both within and beyond Brown.

Franco Preparata

This past summer Franco was invited to present keynote lectures at two international conferences: the 6th International Conference on Algorithms and Complexity, held in Rome, and at the 12th International Computing and Combinatorics Conference (COCOON'06), held in Taipei, Taiwan. He spent most of the summer at the National University of Singapore, participating in collaboratory research and consulting on the peda-

gogy for transdisciplinary research. Franco was also appointed to the Academic Research Fund Panel by the Ministry of Education of the Republic of Singapore for research in information technology and mathematics.

John Savage

John published a journal article in April entitled "Radial Addressing of Nanowires," with Eric Rachlin, André DeHon, Charles M. Lieber, and Yue Wu in the *ACM Journal on Emerging Technologies in Computing Systems*. This article presents a promising new method of controlling nanowires by encoding them through the use of shells of different types of material. A patent application on this work has been filed. In September he gave an invited talk entitled "Specification and Analysis at the Nanoscale" at a Schloss Dagstuhl Conference, Computing Media and Languages for Space-Oriented Computation. He continues his research collaboration on nanotechnology with colleagues at Harvard, the University of Pennsylvania, and Ecole Polytechnique.

In the Department, John finished a year as Chair of the Curriculum Committee which not only introduced revisions to the A.B. and Sc.B. concentrations but also reviewed and organized summaries of entry-level courses. He taught CS159, Introduction to Computational Complexity in the spring and is now teaching CS257 Introduction to Nanocomputing. At the University level, John continues to be an active member of the Faculty Campaign Committee.

Don Stanford

I am entering my sixth semester as the instructor for CS2 and it's hard to believe that I've been teaching for almost five years! As the course requires continuous curriculum updating, I'm sure that I've learned almost as much as the 1000+ students who have taken the class during my tenure.

During my "spare" time I have been serving as the President of Times2 Academy, one of RI's most successful public charter schools. A Times2 graduate is now a member of the Brown Class of 2010 and I am serving as his freshman advisor. I have also been working as the Chair of the RI Business Innovation Factory, a non-profit organization that is fostering collaborative innovation projects in RI (www.businessinnovationfactory.com). I will also be an instructor helping out in EN211, Business Fundamentals, which is a new course in the PRIME curriculum (Program in Innovation, Management and Entrepreneurship) offered by the Division of Engineering

In addition to these activities I have been writing a book entitled *Demystifying Digital*, a primer on the workings and significance of the digital world that so many of us take for granted. Hopefully I can get Oprah to read a chapter or two and put it in her book club!

I spend a great deal of time at my home in St. Thomas, Virgin Islands where I am engaged in serious digital astrophotography. One of my recent favorites is an image taken last spring of M42, the Orion Nebula. This photo (see below) is comprised of over 50 individual images that are aligned, stacked, combined and processed on my PC.

Eli Upfal

Eli taught a summer course entitled Stochastic Analysis of Dynamic Networks, as part of the Algorithms and Models for Dynamic Networks summer education program organized by the European project DYNAMO on dynamic communication networks this past June.

In July, while on a family vacation in Brazil, Eli gave a talk at the Institute of Informatics at The Federal University of Rio Grande do Sul, and was a plenary speaker at the 26th Congresso da Sociedade Brasileira de Computação in Campo Grande. In a typical Brazilian tradition, Eli received the ticket to the conference less than 24 hours before the flight, but the conference was great fun.

Eli also spent two weeks visiting the new Yahoo! Research lab in California and was very impressed with Yahoo!'s commitment to open research and the high quality of researchers they have hired in relatively short time.

Andy van Dam

On July 1st, Andy van Dam officially stepped down from his role as Brown's first Vice President for Research. To celebrate his newfound freedom, Andy and Debbie spent ten days in Switzerland hiking, eating well, and relaxing. (!)

At the end of July, Andy gave a presentation on pen-centric computing at the annual Microsoft Research Faculty Summit. He returned to New England in time to attend the SIGGRAPH conference in Boston, including the annual Brown reunion. Andy and the Graphics Group hosted a demo-fest in the Department for friends and alumni who had attended SIGGRAPH and then Andy opened his home for an informal barbeque.

The fall semester will find Andy once again teaching both the introductory object oriented programming and graphics courses, and continuing to work with John Hughes on a new edition of *Computer Graphics, Principles and Practice*. Having only one full-time job for the first time in four years will allow him to get back to regular exercise and recreation, and in particular to spend more time with his three grandchildren. This spring, Andy taught Timo, son of Elisa (Brown '86), and his eldest grandchild, to ride his first mountain bike and has also had fun teaching him how to use a sea kayak on Narragansett Bay.

Pascal Van Hentenryck

Pascal was awarded the 2006 Association for Constraint Programming (ACP) award for research excellence in constraint programming. He is the second recipient of this award, which was instituted in 2005. Pascal was also awarded the first RI DEPSCOR grant for his work on adaptive and robust resource allocation and an NSF grant for his work on online stochastic combinatorial optimization. This summer, Pascal gave an invited talk at the International Conference on Uncertainty in Artificial Intelligence (UAI'06) on online stochastic optimization and an invited tutorial on his comet system at the National Conference on Artificial Intelligence (AAAI'06). **C!**

New Faculty Profile: Benjamin Raphael

Brown News Service

It's cancer's sneaky multiplicity that intrigues Benjamin Raphael. "The amazing part to me is just how many mutations there are in cancer."

Raphael can count them. His work is a hybrid of math and computer science. He designs algorithms to look at the human genome sequence, with a major focus on cancer genomics. According to Raphael, biology is undergoing a revolution spurred by the advent of genome sequencing and high-throughput experimental technologies that are transforming biology into an information science. In this new era, computational and mathematical techniques are essential to advance the understanding of biological systems. His research interests are in the development and applications of such techniques.

"With technology like genome sequence technology, you can address some questions in a purely computational way…there's a lot of power to sort out what's real, and what's not… I'm especially excited to do something on a computer, then see it in the lab," he says.

In joining Soren Istrail and Chip Lawrence, Raphael is intrigued by working at the boundaries of more traditional fields of study. "Brown seems to have a long tradition, of interdisciplinary work, so there aren't some of these barriers between departments, of people not talking to each other like at bigger institutions."

Raphael earned his Sc.B. in mathematics and biology from the Massachusetts Institute of Technology in 1996, and his Ph.D. in mathematics from the University of California–San Diego in 2002. He held an Alfred P. Sloan postdoctoral fellowship at UCSD until 2004, and was then awarded the Burroughs Wellcome Career Award at the Scientific Interface, a significant honor for postdoctoral fellows.

Raphael is intrigued by the cutting edge at the Center for Computational Molecular Biology, commenting, "The Center is a recent startup – there really seems to be a commitment from the University to this new field." **C!**

Further information:

www.cs.brown.edu/people/faculty/braphael.html

Wandering the Web

Wandering the Web is a regular column featuring recommended web resources and diversions. This issue's featured contributor is Anne Spalter.

The field of computer or new media art has become an accepted genre, and computer use has become part of many traditional art making processes as well. Here is a selection of reference sites, some artists to check out, and tools you can use for your own artistic experiments.

The Digital Art Museum.With a physical presence in Berlin, a city of growing importance in the art world, and a long-time online presence, the Digital Art Museum "aims to become the world's leading online resource for the history and practice of digital fine art." www.dam.org

BITforms Gallery You don't have to go to Europe see new media art, though. Right nearby in NYC is Steven Sack's BITForms Gallery on West 20th Street. The Web site has images from the current as well as all the past shows. www.bitforms.com

Graphics Group Grads in the Art World A surprising number of Graphics Group graduates, including Cassidy Curtis, Scott Draves, Brian Knep, and Scott Snibbe, have gone on to become award-winning digital artists. Brian Knep is currently the first Artist in Residence at Harvard Medical School. His biomorphic, organic-looking animations are based on chemical models. www.blep.com

Make Your Own Computer Art. You can experiment with the same algorithmic system used by notable digital artist Casey Reas with the ever-evolving open source animation programming language "Processing." http://processing.org/

rhizome.org What's happening in new media? A blog, gallery, and community platform by Mark Tribe, Assistant Professor in Brown's Department of Modern Culture and Media.

teleculture.com Frank Dietrich's blog, with "comments on cultural events, tech art, digital aesthetic, etc." Perceptive postings and links to Dietrich's essays as well as to new media artists and related web sites. **C!**

Faculty Awards and Honors

RoxyBot'06 Receives First Place International TAC Award

After seven years of hard work perfecting the design of RoxyBot, Brown's entrant in the international Trading Agent Competition (TAC) travel game, Assistant Professor Amy Greenwald, Ph.D. student Victor Naroditskiy, and undergraduate Seong Jae Lee were pleased to announce that RoxyBot snatched a first place victory from the jaws of Michigan's Walverine.

ABOVE Assistant Professor Amy Greenwald (right) discusses RoxyBot strategy with undergraduate student Seong Jae Lee (left) and Ph.D. student Victor Naroditskiy (center).

TAC is an international forum designed to promote and encourage high quality research into the trading agent problem. In this competition, a simulated TAC Travel agent must organize itineraries for clients who wish to secure round-trip travel arrangements, accommodations, and entertainment tickets. The agent's objective is to procure those goods that best satisfy its clients' preferences as inexpensively as possible, by trading in ascending call markets, continuous double auctions, and dynamic posted-pricing environments, simultaneously. Visit www.sics.se/tac/ for details.

Pascal Van Hentenryck Receives DEPSCoR Award

Professor Pascal Van Hentenryck received a Defense Experimental Program to Stimulate Competitive Research (DEPSCoR) award for "Adaptive and Robust Resource Allocation and Scheduling." The funding will support research on developing novel computer applications, based on mathematical modeling, for fast and efficient decision making.

Of the 103 projects submitted, twenty-five were competitively selected. This is the first DEPSCoR award for Brown and Rhode Island, which is designed to expand research opportunities in states that have traditionally received the least funding in federal support for university research.

Philip Klein Awarded NSF Theoretical Foundations Research Grant

Professor Philip Klein has been awarded a $300,000 grant from the National Science Foundation. The funding will support Klein's research on algorithms for solving optimization problems on planar graphs – graphs that can be drawn on the plane with no crossings. Such graphs are necessary in image processing and road map logistics.

Possible uses for planar graphs research are illustrated by the following scenario –imagine a truck driver who must develop the shortest possible route to supply vending machines at numerous locations. This scenario is a version of the infamous Traveling Salesman Problem; and finding the shortest route that visits all required locations is considered a computationally intractable problem.

Klein's prior work implies that because a road map is essentially a planar graph, for any percentage error tolerance $\varepsilon > 0$ desired, there is an $O(n \log n)$ algorithm to find a route whose length is at most $1+\varepsilon$ times that of the shortest. The grant will support Klein's continuing efforts to discover and mathematically analyze algorithms of this kind.

The Theoretical Foundations Program received approximately five hundred proposals, of which 15% received support.

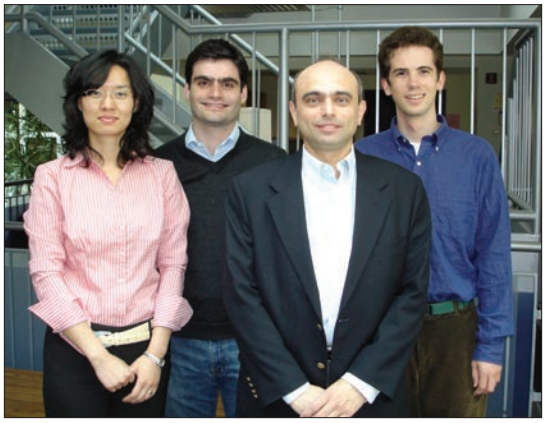
John Jannotti Awarded NSF Computer Systems Research Grant

Assistant Professor John Jannotti has been awarded a $380,000 grant from the National Science Foundation's Computer Systems Research Program. The award, for "Safe at Any Speed: Safe and Fast Distributed Applications," will fund research that will simplify the development of large concurrent systems. The research aims to avoid "race conditions," a type of software fault common to parallel programs, and to help developers monitor the operation of large distributed applications.

This year the Computer Systems Research Program reviewed 350 proposals for 299 projects and funded approximately 10-15% of them.

Faculty Awards and Honors

Technological Innovation Award for Roberto Tamassia and the Center for Geometric Computing



ABOVE Members of the Center for Geometric Computing recently received Brown's Award for Technological Innovation. Included in the photo are (from left to right): Ph.D. candidate Danfeng Yao, recent Ph.D. recipient Nikos Triandopoulos, Professor Roberto Tamassia, and undergraduate David Ellis.

Brown University's Award for Technological Innovation was presented to Professor Roberto Tamassia and members of his research team at the Center for Geometric Computing for their work on data authentication in distributed environments. In addition to Roberto, research collaborator Michael T. Goodrich, recent Ph.D. recipient Nikos Triandopoulos, Ph.D. candidate Danfeng Yao, and undergraduate David Ellis were mentioned in the award.

The award, which honors faculty and students for their efforts in creating technologies with licensing potential, was presented by President Ruth Simmons, Associate Vice President for Technology Partnerships Charles Kingdon, as well as then Provost Robert Zimmer, who is now at the University of Chicago, and then Vice President for Research Andy van Dam, who is a professor of computer science.

The authentication technology for which the award was given has been licensed by Industrial Partners Program (IPP) member IAM Technology, Inc. as part of a multi-year research and development partnership with the Center for Geometric Computing. Ph.D. candidate Charalampos Papamanthou recently joined the center and is contributing to this effort.

Best Paper Award to Michael Black and Leonid Sigal

"Predicting 3D People from 2D Pictures" co-authored by Ph.D. candidate Leonid Sigal and Professor Michael Black, won the best paper award at the Forth International Conference on Articulated Motion and Deformable Objects (AMDO-e 2006) in Mallorca, Spain.

Sigal's research focuses on building vision systems that can detect and track people in images and video. Such vision systems have many applications in the entertainment industry, rehabilitation medicine, surveillance and robotics. Black and Sigal's latest work uses statistical models and a novel hierarchical probabilistic framework to infer the 3-dimensional (3D) pose of a person from a single image. This is a particularly challenging computational problem given the flexibility of the human body and the inherent ambiguity involved in computing a 3D articulated model from a 2-dimensional (2D) image.

This new framework breaks the problem down into a hierarchy of subproblems. First they detect the location of possible body parts in the 2D image and combine them into a "cardboard person" model using a probabilistic graphical model. Machine learning methods are then used to predict 3D body poses from the 2D model. The result is one of the first complete systems for estimating 3D body pose directly, and automatically, from images.

Shriram Krishnamurthi Awarded NSF CyberTrust Grant

Associate Professor Shriram Krishnamurthi has been awarded a $400,000 NSF CyberTrust grant for "Representation, Analysis, and Verification of Access Control in Dynamic Environments."

The research tackles the policies that dictate the security of systems. Mistakes in these policies can have awful consequences: an error can cause a system to blithely publicize private data, thereby perhaps even violating legal statutes. Unfortunately, the sophistication of these policies and their subtle interaction with programs makes them difficult to construct correctly.

These dangers raise a natural question: how can policy authors tell whether a policy captures their intent? The work proposes novel techniques to analyze policies, taking into account how the corresponding tools will get used in practice instead of producing boilerplate "verification" techniques typically found in the literature.

This is joint research with Dan Dougherty and Kathi Fisler of WPI, and is based on prior research and discussions with alumni Pete Hopkins, Michael Carl Tschantz, Seth Proctor, and current student Leo Meyerovich. **C!**

Do We Need a Next-Generation Internet? Industrial Partners Program Symposium 2006

Assistant Professor **John Jannotti**'s research is focused on how overlay networks and peer-to-peer systems ease the deployment of fundamental changes to Internet protocols by allowing innovation without consensus. He is also interested in the challenges of efficiency, fairness, and scalability, which temper the freedom to innovate in this context.

The Department's 36th Industrial Partners Program Symposium asked the question, "Do we need a next-generation Internet?" On May 1, 2006, over 50 attendees – professors, industrial partners, and students – came together to find out. The talks were wide ranging from thoughts about new Internet services and programming paradigms to the changing face of Internet security.

The Internet has been a remarkable success by almost any metric. It has changed the way we communicate with colleagues and friends, whether through email, instant messages, message boards, or voice-over-IP. It has changed the way we conduct business, from Amazon to online advertising to the mobile "Starbucks office." Adding in innovations like web search, online maps, file sharing, and Internet poker and it seems as though the late 90s day-trader's slogan that, "The Internet Changes Everything," might actually be true.

ABOVE Symposium participants included: (top row) Erich M. Nahum, Prem Gopalan, Dave Andersen, (bottom row) Steve Resnick, Bobby Blumofe '88, and John Jannotti.

Yet there are networking tasks that the Internet was never designed to perform. The Internet's "best-effort" service model was not designed for the reliability we expect in the telephone network. Its unicast addressing model is unsuitable for replacing the massive multicast demands of the television network. Routing based on IP addresses that reflect physical topology makes mobility difficult. The stateless nature of web servers makes web applications difficult to write. Perhaps most worrisome, security has been an afterthought at every layer.

Some argue that these shortcomings demand a new design for a next-generation Internet. Others point out that, while the Internet may not have been designed with these applications in mind, it is being used for every one of them and perhaps there is no need for fundamental change. In the 36th IPP Symposium, we looked at the applications that are pushing the Internet in these new directions, and considered the case of Evolution vs. Revolution.

In the morning's first talk, Erich M. Nahum of IBM's T.J. Watson Research Center discussed the Session Initiation Protocol (SIP), which he argued was enabling important next-generation network services.

Although SIP is most frequently known as the signaling protocol for Voice over IP (VoIP), SIP also enables many other applications, including audio and video conferencing, presence, instant messaging, and event notification. Nahum described how (and why) SIP is gaining adoption in IBM and the industry as a whole for these services.

IBM's interest stems, in part, from SIP's status as an open standard, allowing for deployments that avoid lock-in proprietary technology. Of course, IP's openness is an important reason for the Internet's success, so SIP has history on its side.

The morning session concluded with a talk from Steve Resnick of US Microsoft Technology Centers entitled, "Designing Distributed Applications with Workflow, Messaging, and Services." Resnick described Microsoft's vision (and soon-to-ship products) for developing Web Services that include long-lived tasks. Such a service might not only process a customer's online order, but also usher the order through the vendor's internal shipping workflow.

Resnick argued that when these services implement complex transactions, a transient state between service requests must be maintained within the service. Such an application might call out to several other services, requiring complicated roll-back logic when services fail. These services must coordinate work across multiple services either within an organization or at Internet scale.

The afternoon session began with a talk from Prem Gopalan of Mazu Networks. Mazu Networks builds security products that monitor networks for security threats such as denial of service attacks and worm propagation. Gopalan discussed the problems Mazu addresses, and some of the algorithms behind their systems in, "Signature Metrics for Accurate and Automated Worm Detection."

Explaining that worms can propagate through a network in minutes or seconds, Gopalan argued that automated mitigation is required. Further,

since recent studies have shown that content-based filtering is more effective than address-based filtering, Mazu has concentrated on the development of automated worm signature generation systems.

In worm detection, a false positive might lead to blocking real, desirable traffic. Though whitelists that explicitly allow certain traffic may mitigate this problem manually, Mazu has found that the false positives can be greatly reduced by capturing some key differences between worm and normal traffic. Gopalan described a few of these differences, and shared the results from a prototype deployment on a large university network.

The second talk of the afternoon, by Professor Dave Andersen of Carnegie Mellon University, addressed Data-Oriented Transfer, or DOT, a flexible architecture for data transfer. DOT separates content negotiation from actual data transfer. Applications determine what data they need to send and then use a new transfer service to send it.

DOT acts as a common interface between applications (say, sendmail) and the lower-level network layers, facilitating innovation both above and below. The transfer service frees developers from re-inventing transfer mechanisms in each new application. New transfer mechanisms, in turn, can be easily deployed without modifying existing applications.

Bobby Blumofe '88, Chief Architect at Akamai Technologies and a computer science graduate, ended the day with his talk, "Overlaying and Underlaying the Internet," which made the case that the Internet's basic design has been an enormous success, and is in little need of overhaul.

Blumofe argued that it is the very stability of IP that has allowed for the proliferation of Internet underlays, like home broadband and wireless, and Internet overlays, such as Akamai's network. These underlays and overlays extend the Internet to serve roles that were not envisioned at the time of writing the IP specification. After making this case in general, Bobby went on to describe how Akamai's overlay network builds on top of IP covenants and provides services, such as guaranteed performance and reliability, that are not present in the core Internet.

The day's talks represented a large cross-section of innovation in the networking field, both academic and industrial. The IPP program at Brown is designed to bring together these worlds for the benefit of both, and we're happy to report that the interaction between participants, both in and out of the talks, leads us to believe it is succeeding.

We would like to thank the co-Directors of the IPP Program, John Hughes and Michael Black, our Chair Eli Upfal, and Laura Zurowski for their support in making this program happen. Of course, the day would not have been possible without the generous contribution of our speakers, and the interest and enthusiasm of our attendees. We express our deepest thanks to all, and hope to see them again next time.

Our December 2006 symposium will be hosted by Sorin Istrail, who will present "The Genome and the Computational Sciences: the Next Paradigms" featuring distinguished lectures by Nobel laureate Leon Cooper, Pavel Pevzner, David Altshuler, David Shaw, and other visionaries in the field of computational biology. See www.cs.brown.edu/ipp/symposia/ for details. **C!**

"In the 36th IPP Symposium, we looked at the applications that are pushing the Internet in these new directions, and considered the case of Evolution vs. Revolution."

Industrial Partners Program

The primary goals of the Industrial Partners Program (IPP) are to exceed the expectations of our partner companies in terms of recruiting and outreach; to allow our faculty to engage in challenging and meaningful research collaborations; and to provide resources, funding, and employment to our students.

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

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To learn more about IPP visit:
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Parenthetically Speaking

Parenthetically Speaking is a feature column by Associate Professor **Shriram Krishnamurthi**. An unabridged version of this book review can be found at www.cs.brown.edu/~sk/Personal/Books/.

ABOVE Shriram takes the offensive and counters Eugene, mashes it up with Google Maps at a mystery location, and explores the advent of fingerprinting.

I threatened in my first column that I might expand its range. What's easier than littering it with casual observations informed by trivia, a style familiar to readers of these pages? So here goes… Open up Google Maps, visit Providence, zoom in at the highest resolution, and scroll around the Brown campus area. You'll see a grey zone covering the Brown University Athletic Complex, just south of the East Side's undulations.

I recently compiled a Google Maps mash-up of the restaurants on and around Thayer Street. This resulted in a long, thin map of the area, at the top-right of which were the letters "D" and "A" on two separate lines.

I spent a few moments wondering what this might stand for. Nothing came to mind, so I scrolled the map…to find the legend, "Dexter Asylum"! Was this a prank by one of our alums? Was this a Mountweazel?

Neither, it turns out. There was indeed, on that very site, an institution by that name. A wonderful article on the Rhode Island Historical Society Web site says that the it was an "institution for the care of the poor, aged and mentally ill of Providence from 1828 to 1957"; the residential growth of the East Side put an end to it.

The question remains, how come it's on one map and not the other? As Pete Hopkins '04, '05 Sc.M. pointed out, as of this writing, Google Maps uses NAVTEQ whereas the API uses TeleAtlas. Sure enough, blogspace is alive with comparisons of the two; a common opinion seems to be that NAVTEQ's data tend to be newer and more accurate, but I am no authority.

To return to my original focus of book reviews, this issue's selection ties into the theme of crime and identification. Michael Black's course highlights the power of computing at identifying criminals. But crime is much older than computing, and the law has long recognized the value of classification, storage, and retrieval. Fingerprinting is an especially important milestone in these processes, and this book illustrates an important facet of its development.

***Imprint of the Raj*, Chandak Sengoopta**

We have always "known" that fingerprints are unique identifiers. This begs a few obvious questions: How do we actually know that? When did we know it? Like a scientist unraveling a problem, Sengoopta dissects these questions to reveal far more of interest and curiosity than we might have imagined.

The pressing need for identification arose in the West with the rise of the city, which provided anonymity that was especially dangerous in the hands of criminals. Enter Alphonse Bertillon's strategy of biometrics, which were adopted enthusiastically. Bertillon's strategy had two benefits: it could identify repeat criminals and, equally important, it lent itself to efficient indexing and retrieval.

Bertillon's system, however, suffered from several major flaws: the difficulty of making accurate measurements with instruments of insufficient sensitivity and officers with limited training, the changing of these measurements over time, and the duration it took to make accurate measurements. Very few crime scenes contain many (or any) impressions that can lead to tracing by Bertillon's scheme. So the police were ready for something at least complementary.

The value of fingerprints as a means of identification had been noticed several times and in several places. But it was in India that a British administrator began to systematically collect prints of just about everyone he encountered, thus assembling a huge database. His experiment had two critical features. First, he had lots of latitudinal data: numerous people of all ages, races, castes, and so on. Equally importantly, he also had lots of longitudinal data: the fingerprints of the same people recorded over time, starting with his own. The administrator's name was William James Herschel: yes, the scion of *those* Herschel's, told by his father to pursue a career in something other than astronomy.

This book is the story of three main people. Herschel, we have seen, gathered the data. Francis Galton studied them extensively and wrote the seminal book about it, and Edward Henry was credited with the indexing scheme that made it possible to discard the use of Bertillonage entirely.

This is the kind of smart book that includes an appendix on the evolution of fingerprint classification, and is enlivened by several excellent illustrations, not least the cover of Galton's book *Finger Prints* that features Galton's own prints as the cover art. All books should be this educated, informative and yet such an enjoyable read. **C!**

Numb3rs: Criminal Outreach

Assistant Professor **Meinolf Sellmann**'s research focuses on hard combinatorial feasibility and optimization problems as they arise in the context of real-world applications such as airline crew scheduling, automatic recording, and capacitated network design.

In CBS' new hit series *Numb3rs*, FBI agent Don Eppes (Rob Morrow) recruits his brother and applied math professor Charlie Eppes (David Krumholtz) to help him solve various crimes in Los Angeles. Whether they try to locate the home of a serial killer, the origin of a deliberate outbreak of the Spanish flu, or the time and place of the next bank robbery: math always plays a decisive role to bring the bad guys to justice.

"When Charlie puts his headphones on and furiously scribbles formulas onto a chalkboard, which his student later caresses as if she could touch beauty itself, the audience is inclined to think that being a mathematician cannot be so dull after all."

Clearly, CBS pursues an educational agenda when trying to portray mathematics, for many not the most favorite subject in school, as an important and useful subject that can actually be quite hip. Logically, the hero of the show is very much unlike Hollywood's usual cliché scientist a la Dr. Peter Venkman (played by Bill Murray in *Ghostbusters*) or Dr. Emmett Brown (Christopher Lloyd in the beloved trilogy, *Back to the Future*). With Krumholtz, a name better suited for a mathematician than for an actor, CBS has found a young, tanned face with dark eyes and black, curly hair that makes science look the most attractive since Jeff Goldblum starred in *The Fly*. When Charlie puts his headphones on and furiously scribbles formulas onto a chalkboard, which his student later caresses as if she could touch beauty itself, the audience is inclined to think that being a mathematician cannot be so dull after all. The thought even occurred to me and the effect lasted until Mrs. Sellmann, not seeing the beauty at all, snatched my notes together and told me not to leave them lying around all over the place…

All this is superficial of course. But what about the math behind *Numb3rs*? Mathematics consultants take part in the production to ensure that the math used to help analyze and solve crimes is real and accurate. Consequently, the central formulas you see on the show are not mere window-dressing, but actual equations suited to predict, for example, how fast an epidemic spreads among a population. However, while the math is ok, the over-simplifications in the script do undermine its credibility. In one episode a college student dies after a fall from a bridge. Charlie determines, using only his eyes and without any device to measure wind velocity, a one foot deviation from the place where the student should have landed had he been alive when he fell. Al-right! What is also disappointing is that the show has a tendency to obscure the challenge of modeling behind the use of empty buzz words like "multi-variable problem" or "multiple vectors." This way, the chance is missed to convey how sensitive predictions are to initial assumptions and the selection of parameters that one chooses to take into account – an awareness that would certainly be desirable to be found in the general public.

However, in general, the idea to advertise math and science in a TV series is commendable, even when the educational part is largely based on simplifying analogies. Texas Instruments, in collaboration with the National Council of Teachers of Mathematics, has based its education initiative "We all use math every day" on *Numb3rs*. The outreach program suggests classroom activities preparing students grades seven to twelve for the math used in the next episode. While the objective to make math more attractive to students is laudable, the subject of the TV series does not appear appropriate for students at all levels. After all, *Numb3rs* remains a crime show dealing with strong content like serial rapes, a student suicide, or an introduction in how to cut a throat most effectively. Good education for a seventh grader? You do the math! **C!**

Unplugged

Professor **Eugene Charniak**'s research is in the area of language understanding or technologies which relate to it, such as knowledge representation, reasoning under uncertainty, and learning.

In the last issue of *Conduit* I was astounded to discover not just my column, but two others – and one of them had the "parenthetical" temerity to describe my column as "so 1990s"! Let me tell it to you straight – don't bother reading those others, just mine. They are a couple of wannabes. I am the real McCoy. (Do you know the joke for which this is the punchline? Unfortunately it is too filthy for this magazine, but stop by some time and I will tell it to you.)

I was pleased to be invited to give a talk at the AI@50 conference this summer at Dartmouth. The field of Artificial Intelligence is generally considered to have been established at this conference in the summer of 1956, when John McCarthy and Marvin Minsky, two of the founding fathers of the field, coined the term "Artificial Intelligence," when applying for a grant to fund the conference. The rest is history. AI@50 commemorated the 50th anniversary of this event and in attendance were five participants from the original conference, including Minsky and McCarthy, who are still alive and doing fine.

ABOVE Eugene declares war on the new *Conduit* columnists, discusses AI@50, and waxes sentimental about chairs.

While it was an honor to be invited, as a conference it was somewhat disappointing. Too many of the speakers took it as an opportunity to step back and try to address the field as a whole, rather than talk about their new research. While one is always told to do this, it is almost invariably a mistake. A genius like Hilbert can step back and list the ten most important open problems in mathematics and set the agenda for the next century. The rest of us are better off speaking about our specific research areas. The talk which I enjoyed the most was one given by Leslie Kaelbling, a former faculty member in the Department until MIT lured her away, who discussed her new work on problem solving in non-deterministic domains. A traditional deterministic domain is the so-called "blocks world." In this scenario a robot arm is given a set of blocks and the task of creating a stack of blocks of a certain size. Leslie noted that in the real world robot arms often set the blocks down with such inaccuracy that the stack topples; in response, she created a world in which the arm motions are somewhat random, and the results are determined by the real physics applied to the random arm positioning. It was a fascinating talk.

I discussed my research on statistical parsing, broadening it only to the extent that I could make the point that statistical methods are an important and relatively new addition to the field.

I assume that elsewhere in this issue, in big bold headlines, is the news that I have been named University Professor of Computer Science. In academic parlance I now have a "named chair" and am considered extra special. When I told my wife this news, she kissed me and refrained from criticizing me for having spilled coffee on my shirt.

What really surprised me about the named chair bit was that I had no idea it was in the works. If you don't understand my surprise then you don't know how things work in academia. For example, when professors come up for tenure we first send out letters asking other professors to give us their opinions of the faculty member in question. If both they and the department are favorably disposed, the department writes up a recommendation to the university committee in charge of such things. This recommendation typically says how the professor walks on water and can turn wine into orange juice. When I came up for tenure, Andy van Dam was chair of the department, and he made me write up my own tenure recommendation letter – that action certainly speaks to Andy's skill at delegating! By the nature of this process I knew exactly, to the word, what the department thought of me.

As the saying goes, what goes around comes around. (Actually, I have never understood what this means, but it sounds appropriate.) I was chair of the department when Andy was named University Professor of Computer Science (which he later traded in to become the T.J. Watson Professor of Educational Technology). There was never a doubt in my mind that Andy was overwhelmingly deserving of the honor. Nevertheless, I had to accumulate faculty recommendation letters, and send the administration a detailed memo on why Andy should be given the chair.

Naturally, I made Andy write it.

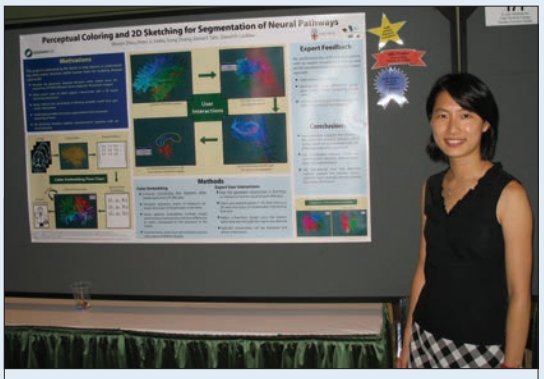
"I assume that elsewhere in this issue, in big bold headlines, is the news that I have been named University Professor of Computer Science. In academic parlance I now have a 'named chair' and am considered extra special."

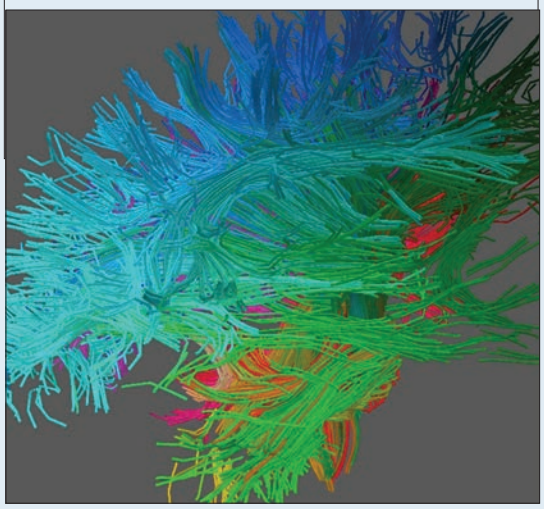
Of course, I had no problem supporting Andy because, as you might know from reading my column, I have always been a big Andy fan. In fact, I have another story that speaks to Andy's recognition within the University during the time before he was named to the University Professor of Computer Science chair.

I had recently become department chair and had to go to one last meeting to finalize the An Wang Professor of Computer Science chair for Franco Preparata. (Thought it is John Savage, who was chair before me, who deserves the credit for getting this through the university committees.) At the very end of this meeting I was asked if anyone else in the department was worthy of a chair. I responded that yes, there was one person. I did not mention names. Afterward, the administrator who asked the question came up to me and quietly said, "I agree." I have never told Andy this story. He would probably think I was getting sentimental on him. **C!**

Wenjin Zhou Receives First Place Award in the ACM Student Research Competition at SIGGRAPH

Wenjin Zhou, a first year Ph.D. student in computer science, received the first place award in the Association for Computing Machinery's (ACM) Student Research Competition at the 2006 SIGGRAPH conference. Her award winning presentation, "Perceptual Coloring and 2-D Sketching for Segmentation of Neural Pathways," utilizes scientific visualization to help doctors understand and analyze white matter structures within the human brain. Zhou, along with co-authors Peter G. Sibley, Song Zhang, David F. Tate, and David H. Laidlaw have developed BrainApp, an application to visualize the geometric disparity between white matter tracts obtained from DT-MRI data by coloring in perceptually uniform color space. The coloring is assigned such that differences in color in a perceptual uniform space correspond to the geometric distances between fiber tracts. The system allows the expert user of the application to interactively select regions with a 2-D based sketching mechanism. This 2-D sketching interface exploits the training neuroscientists have received viewing axis aligned 2-D slices of MRI data. **C!**





Department News and Happenings

Department news items were contributed by **Hong Chau** and **Sarah Filman**, **Brendan Dickinson**, and **Yanif Ahmad** and **Dan Grollman**.

The Artemis Project I

Another summer of the Artemis Project successfully came to a close in late July after five-weeks of introducing twenty-two girls to the foundations of computer science and technology. Each year, four female undergraduates from computer science and related departments are chosen to coordinate the day camp. Under the faculty leadership of Professor Thomas Dean, Artemis '06 was coordinated by Victoria Bartolome '09, Sarah Filman '08, Arushi Pasricha '09, and former Artemis participant who was the first from the program to attend Brown, Hong Chau '09.

ABOVE The Artemis 2006 coordinators (from left to right): Sarah Filman, Victoria Bartolome, Hong Chau, and Arushi Pasricha
BELOW Although learning about science and technology are the main goals of Artemis, there is ample time for fun and socializing.

The Artemis coordinators make the program a reality: recruiting rising 9th grade girls from local middle schools, planning field trips to the Boston Museum of Science and the AI lab at MIT, inviting guest lecturers, and creating the daily curriculum. Topics covered this year included Microsoft Office, Adobe Photoshop, HTML, Jython, and programming Lego Robots in C. Interested in more than just teaching concrete topics, the coordinators strove to inspire the girls to pursue their education, open their eyes to the possibilities that computers and technology can provide, and instill a level of confidence that is so easily lost for girls entering high school.

Sponsorship for Artemis 2006 came from the Computer Science Department, Brown's UTRA program, an anonymous donor, and three corporate sponsors: Google, Goldman Sachs, and Microsoft. Three Brown alumnae from Google (Susannah Raub '04, Sarah Bell '05, and Shirin Oskooi '05) visited the Artemis girls to talk about what it's like to work at Google and gave various product demos. Susannah and Sarah have the special distinction as former Artemis Coordinators, and they were happy to revisit the program. A few weeks later, female representatives from Goldman Sachs, including Brown alumna Victoria Choi '05, presented a talk that stressed the importance of technology in any profession.

Although teaching and learning are the main goals of Artemis, the summer would not have been successful without some fun and games! The Artemis experience also includes field trips, games, pizza, kickball, and time to relax. The end result was a group of girls who developed friendships, related to and looked up to the coordinators, and truly grew to appreciate technology. A big 'thank you' must go out to everyone who helped Artemis run smoothly, as well as the Artemis 2006 girls, who were an amazing group of talented young women.

RoboCup Update

In April 2006, Brown CS sent two teams to compete in RoboCup in Atlanta, Georgia. RoboCup is an international robotics competition designed to promote research in AI and robotics, and consists of several divisions for competition. Brown's division involved programming teams of four Sony Aibo robot dogs to play soccer.

Before a team strategy can be developed, problems pertaining to AI and robotics must be addressed. Perception is mainly accomplished via a camera in the Aibo's nose, thus computer vision concerns must be tackled. A motion model to move the Aibo efficiently from point to point and a method of localizing its position in the world must also be developed. All of these issues must be addressed before the Aibos can begin to play soccer. And if that's not enough, executing decisions with speed is of the utmost importance, because, just like in the real world, the slow team never wins.

Organized by Assistant Professor Chad Jenkins, Brown submitted two teams. One team was a rules-based team, and the other leveraged recent work in machine learning to learn game time behaviors from human demonstrators.

As a first year team with only three months of preparation, the two teams had a very successful outing. Considering that most teams are unable to score a goal in their first year of competition, it was a cause for celebration when Brown's rule-

based team was able to score in two games, reaching two 1-1 draws. This positive outcome has energized the team members and hopes are high for a successful run at the 2007 RoboCup.

CS Faculty-Graduate Student Retreat

This past May, Brown CS hosted the first annual Faculty-Graduate Student Department Retreat at the Haffenreffer Museum of Anthropology in Bristol, Rhode Island. The event aimed to strengthen the sense of togetherness between faculty and graduate students with a day of talks, panels, and games. The location was ideal – it provided green lawns and sunshine, and forced all to take a break from e-mail and web browsers.

The day began with six half-hour talks from faculty and graduate students reflecting the diverse nature of the department's research and covering the major areas of artificial intelligence, graphics, systems, and theory. Professors Pascal Van Hentenryck, John Jannotti, and Chad Jenkins, and graduate students Nikos Triandopoulos, Olga Karpenko, and Frank Wood, took to the podium to present their latest work and responded to lively questions from the audience.

A quick lunch invigorated everyone in preparation for the much-anticipated panel discussion. Senior faculty participated as panelists and Ph.D. student Dan Grollman moderated questions ranging from the philosophical, "What is computer science?" to the more mundane, "How do I get a job?"

Following the panel, the group proceeded to the final session - the team challenges. Participants were divided into randomly chosen teams to compete in games challenging their mental, physical, and communication abilities. Tasks included cleaning up a toxic waste dump, building a skyscraper, and dexterous manipulation of a rotating object.

The retreat was a great success, thanks to all the willing participants. In addition to those mentioned above, special thanks go to the organizing committee of Janet Eager, Frank Wood, David McClosky, Jenine Turner, Ugur Cetintemel, and Eli Upfal. We hope that the retreat establishes itself as a tradition in the yearly calendar. Look out for future retreat reports in *Conduit*. **C!**

TOP Congratulations to Kanellakis fellows Aris Anagnostopoulos (pictured left with Professor Eli Upfal) and Nikos Triandopoulos (pictured right with Professor Roberto Tamassia) for completing their Ph.D. programs. **MIDDLE** (left) The fall undergraduate admissions recruiting event attracted over 150 high school juniors, seniors, and their parents. Computer science concentrators, distinguished by the blue t-shirts, presented demos, answered questions, and made everyone feel at home. (right) Graduate students talk a break and enjoy a hot drink at the Faculty-Graduate Student Department Retreat. **BOTTOM** Merriment and pride abounds on Commencement! The Department's celebration was held on the third and fourth floors of the CIT and was attended by over 200 graduates, their family members, and friends.

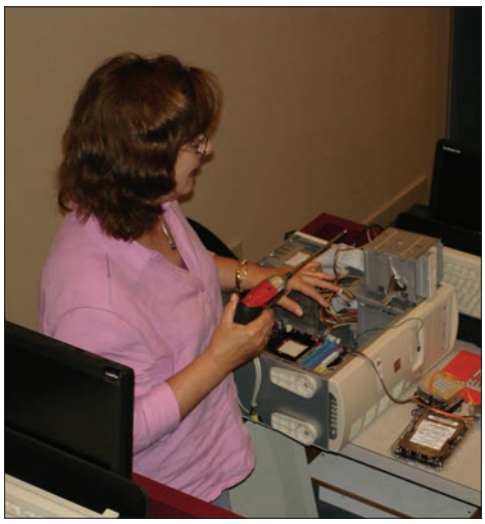
TSTAFF Hardware News

Jeff Coady is the Department's Director of Computing Facilities and **John Bazik** is a TSTAFF Senior Software Engineer. They'd love to hear from former SPOCS, students, and staff about past (and future) upgrades.

With the hardware upgrade of 2006 almost complete, there are few tasks that show up on my "to-do" list that once filled me with more anxiety than the "upgrade the facility" item.

In the past, the process of upgrading the facility was complex, time consuming, and involved large numbers of people. In the late eighties, we planned to upgrade every four years, more recently we've amended that to upgrading every two years.

TOP Max Salvas stands behind every Maxbuilt computer.
BELOW Dorinda Moulton wields a power tool with ease - it's handy for keeping SPOCS on task!
FOLLOWING PAGE While Jeff enjoys working as Max's assistant on upgrades, he's wishes that MaxBuilt had a budget for client lunches!



The focal point for the upgrade effort was the FACIL (short for facility) Committee, now known as the Computing Committee. This committee was comprised of about equal numbers of faculty (including the Chair) and technical staff, and usually included a grad student.

The first step was to produce a document called a Request for Information (RFI) that introduced the department to interested companies and detailed research and educational achievements as well as ongoing efforts. This document also described the current facility and the facility we hoped to purchase. It took many months to compile this document.

Once the RFI was finalized, we submitted it to a variety of workstation vendors including those companies with existing or past relationships with the department. We then entered the presentation/non-disclosure portion of the process. During this phase, which usually lasted a year or so, companies would present their solutions for our requirements and give us a peek at future products. Over the past twenty years these companies have included HP, Compaq, DEC, Apollo, Next, Sun, IBM, Dell, and Microsoft. Presentations were held at a number of sites across the country as well as within the department, with lots of lunches, dinners, meetings, and department research demos. I can specifically recall a visit to HP in Fort Collins and a very memorable trip to Next with John Savage and Andy van Dam where the well-known CEO demonstrated his new workstation and then took us all out for sushi. Now that was an adventure.

With the presentation of the final proposals, the hard negotiations really began. Typically, what we wanted far exceeded our available funds. Several months of wrangling finally reduced the number of players, the amounts involved, and gave us a final set of proposals from which to select. With faculty approval, the FACIL Committee's final decision meant we could proceed with the purchase.

The purchase itself was no simple matter. We had to receive and install the equipment during the summer break and insure that it was up and running by the start of classes. I recall one year when we determined that selling the old and buying new was more advantageous than upgrading. We not only had to negotiate the purchase of the new equipment but had to go through the sales process for the old equipment. As it turned out the company purchasing the old stuff wanted delivery on a specific date or they would reduce their very desirable offer by $18,000. The problem was that we didn't have the replacement systems. Anyone that has been on the technical staff in this department knows that no user can be without a system for more that a few minutes, so we were stuck between the proverbial rack and hard place. As it turned out, we received shipment of 100 systems (complete with monitors) at 3 p.m. the day before the deadline. We deinstalled the old and installed the new (complete with software) by 10 p.m. that evening. At the end of the day, we had our new machines, the used dealer picked up the old machines by the deadline, and we had saved $18,000. It was a remarkable effort.

That was the past. Now most of our workstations (and servers) are Maxbuilts. These are named after Max Salvas, our hardware technician since 1983. We started building these machines in 2002 and called that model the Maxbuilt 1.0. It comprised an Athlon 1800+ with 500MB of memory, a 40GB disk and an Nvidia GeForce3 graphics card.

In 2004, after two years of stellar performance, we upgraded these systems to the Maxbuilt 2.0, a 3000+ with 500MB retaining the same 40GB disk and graphics card. This year we upgraded

"Anyone that has been on the technical staff in this department knows that no user can be without a system for more than a few minutes..."

again. As with the last two upgrades there was no RFI, no cross-country flights, no wining and dining company VIPs, or contentious FACIL meetings. All the new process requires is that I walk down the hall to Max's office (MaxBuilt Corporate HQ). We talk a bit and in an hour or so we have a complete configuration and approximate pricing. (Max has yet to take me, or any of the Computing Committee members, out to lunch to close one of these deals.)

The next step is to build a couple of prototypes and fully test them. With a successful testing and the Computing Committee's approval, we seek out the most advantageous source of components. This year it was the Brown Bookstore. We placed an order for 320 Maxbuilt 3.0's and spent the summer building and distributing them. We reused the cases, CD readers, and floppys (!), replacing the motherboard, memory, CPU, and disk. Maxbuilt model 3.0 is a 64 bit Athlon Dual Core 3800+ with 2GB of memory and a 165GB disk. The components that come out of the upgraded systems are being used to enhance the administrative staff's machines as well as the 40 or so pairs of redundant servers in the machine room.

While I still have nightmares about the upgrade process, I find the current procedure much more manageable and the added benefit is that I enjoy my part-time role as assistant hardware technician, working for Max in building and deploying the new systems. **C!**

Ph.D. Students Receive NSF Graduate Research Fellowship Awards

Computer Science Ph.D. students Jay McCarthy (right) and Warren Schudy (left) recently received awards from the National Science Foundation's Graduate Research Fellowship Program (GRFP).

Jay received a NSF Fellowship and placed in the top 6th percentile of awardees. His proposed plan of research is to create a programming language that eases the development of correct and richly featured Web applications. This language will be amenable to analysis to help guarantee various kinds of safety properties. Jay's award is worth approximately $120,000 over three years.

Warren received a NSF Honorable Mention for his proposal concerning automatic tuning of combinatorial optimization algorithms. While the Honorable Mention does not carry a monetary value, it is considered a significant academic achievement nationwide.

NSF Graduate Research Fellowships 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. **C!**

True Tales from the Tech World: CS Alums Tell-All!

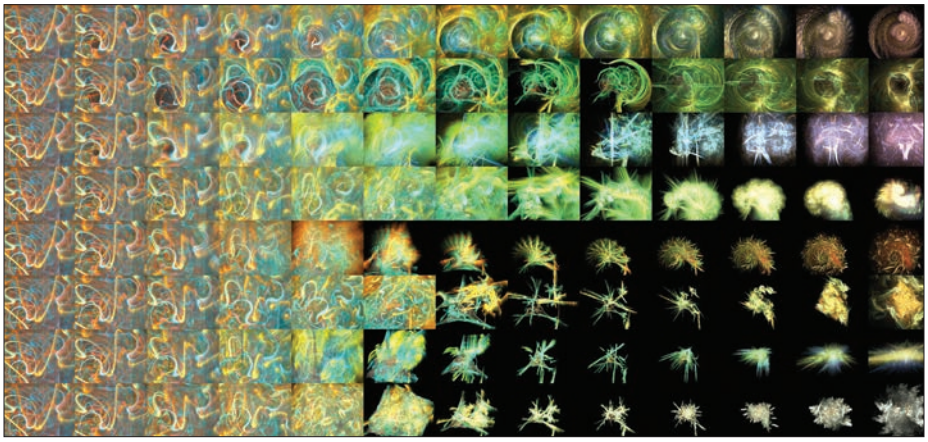
Spot Draves received his Sc.B. in 1990. His work can be viewed online at www.electricsheep.org or draves.org/portfolio/. He can be contacted at spot@draves.org.

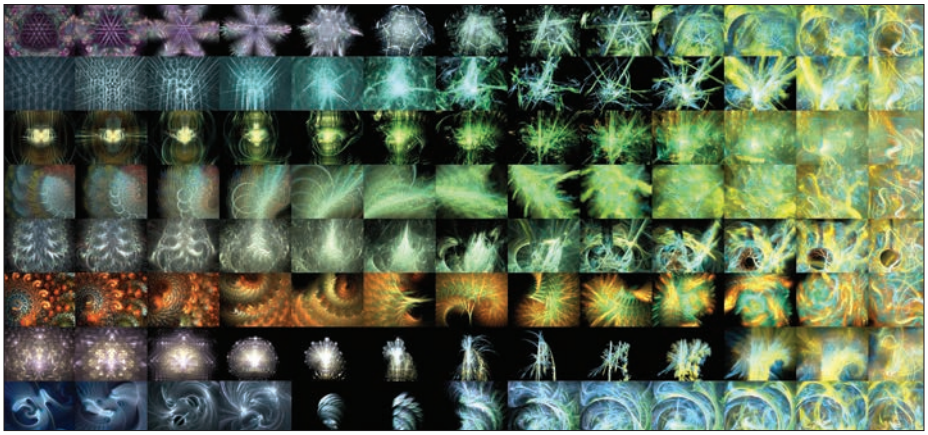
An Idea's Long Journey into Light: the Origin and Evolution of the Electric Sheep

One of the pleasures of working in a laboratory is the unsanctioned project: research done after-hours, without supervision, for sanity's sake. This is the story of one such project, and how it took over my life.

I'm talking about the Electric Sheep: a cyborg mind composed of thousands of computers and people communicating with a genetic algorithm. It's a distributed screen-saver that harnesses idle computers into a render farm with the purpose of animating and evolving artificial life-forms.

The "sheep" are abstract animations, collectively rendered, then displayed on all users' screens. People vote for their favorites, and the genomes of the most popular are combined and mutated to create more sheep. Users also may design sheep by hand for inclusion (under a Creative-Commons license) in the gene pool. The result is an artificial intelligence that seeks to realize the desire of its global audience, and distributes its results for free to all.





ABOVE AND BELOW Spot Draves' artwork highlights good genetic cross-fades between electric sheep. The full *Dreams in High Fidelity* series can be viewed online (and downloaded as a screen-saver) at hifidreams.com.

It started in the late 80s while I was an undergraduate working in the graphics group at Brown. There I learned about iterated function systems, an obscure kind of fractal. Several years later as a Ph.D. student at Carnegie Mellon University, I was interning in Tokyo. My after-hours research continued, resulting in the Fractal Flame algorithm, the visual language that defines the sheep's genetic code.

The software and galleries were open-sourced and posted on the web in 1992 and soon after received an award from the Prix Ars Electronica. Fast-forward to 1999 in San Francisco, surrounded by startups and between jobs, inspired by the SETI@Home project from Berkeley, the distributed render farm that is the Electric Sheep was born, and began to grow.

Generations of sheep passed. Versions were released and forgotten. Users came and went, but some stayed, and told their friends. Eventually it appeared in *Discover* magazine, on the main dance floor at the Sonar music festival in Barcelona, and at the Annecy International Animated Film Festival.

Today, daily, it runs on 35,000 computers and delivers over a terabyte of video with BitTorrent. The client computers would be one of the world's largest supercomputers - if they ran Linpack instead of drawing pretty pictures. A team of about five engineers and numerous artists makes regular contributions.

Two years ago I quit my last day job to farm sheep full time. The first product was SPOT-WORKS, a DVD of VJ-style music-videos, now in its third pressing. The second and most recent is *Dreams in High Fidelity*, a high definition, curated, and edited flock of sheep that would have taken one computer 100 years to render. This "painting that evolves" is available as fine art, with proceeds to support the free network. The intention is to continue developing the software until it becomes a self-supporting, network-resident life-form. **C!**

Kwesi Davis '98 would love to hear from former classmates and friends. You can reach him at kwesidavis@earthlink.net

Gerri (Hnatin) Vitovitch sends her regards to her Sc.M. colleagues from 1984-85. Her email is gvitovitch@earthlink.net.

A Star is Born

When I was at Brown, my name was Kwesi (quA-cy) Davis. These days I go by, "da-da?" That's what Ife (E-fay) calls me. Ife means "love," but we should have named her "Cute-as-a-Button" Davis because that's exactly what my daughter is. So much so, she's got an agent. She's only nine months old but born to be in Hollywood! Her stardom is inevitable.

These days "Da-da" makes feature animation. *Shrek*, *Shark Tale*, *Madagascar*, and *Over the Hedge* just to name-drop a few. If you stay in your seat a second after the movie's over, you'll see me in the Engineering section - which is after the Sound Department, which is after the Art Department, which is after Production Management, which is after the Art Director, Production Designer, Editor, Musicians, Producer, the cast, writers, and the director. Not bad for a guy fresh out of film school!

And not just any film school, *The* Film School: NYU's Graduate Film & Television program. If you're into film, I recommend it; plus it's in the Village. "It takes a village to raise a child." My child is beautiful. She gets it from her mother. Dr. Thema (tAy-ma) Bryant-Davis is a headshrinker. Thema means "queen." Headshrinker means she teaches Psychology, to graduate students, at Cal State University of Long Beach.

ABOVE An animated moment with (left to right) Kwesi Davis, wife Thema, and "cute-as-a-button" Ife.

Speaking of which, California's got some great beaches. They should have named it the "Ocean State," but I guess that was taken. Which brings me back to Rhode Island… I enjoyed my time there, the people, and of course, Brown University.

Be easy, Kwesi '98 **C!**

Hooray for Math Teachers!

I retired from corporate computing back in 1995 to raise a few (five) children. My employers included AT&T, Unix Systems Labs, and finally, Novell. I started out as a systems software engineer and eventually worked in product marketing and technical sales training. The training aspect of the work was my forte.

This fall, with my youngest child starting first grade,I began a new career as a middle school math teacher at Franklin Middle School in Somerset, NJ. This career move began with my participation in New Pathways to Teaching in New Jersey (NPTNJ), an alternate route teaching program via New Jersey City University. It's a crash course in education psychology, classroom curriculum planning, lesson presentation, and teaching observation. The associated research project was an excellent way for me to discover the great web resources available to mathematics teachers, students, and professionals, alike. I expect to complete the New Pathways program soon and should have double certification in elementary education and middle school mathematics when I finish. Between the new job, classes at night, and my family life, I haven't read so much or had so little sleep since my days at Brown!

Our oldest son is a high school freshman; he's shown an aptitude for physics, math, and computers (loved his JAVA class this year) and is a pretty good swimmer. He asks me about Brown every time we're at Princeton for a swim meet; he sees the Ivy league banners hanging over the pool and always seems so astonished "Mom, did you really go to Brown?" (Gotta love a teenager... always underestimating a parent!) He keeps good grades and likes water polo, so maybe Brown's in his future in a few years.

My regards to the members of the Department, and to my Sc.M. colleagues from 1984-5! **C!**

C! Comments?

Send your views to: Conduit,
Department of Computer Science,
Brown University, Box 1910,
Providence, RI 02912
or email conduit@cs.brown.edu

True Tales from the Tech World: CS Alums Tell-All!

Ryan Shaun Joazeiro de Baker received a Sc.B. in Computer Science from Brown in 2000. He can be contacted at ryan@educationaldata-mining.org.

Morgan McGuire received his Ph.D. in 2006. He can be reached through morgan@cs.williams.edu and cs.williams.edu/~morgan.

Educational Data Miner

I went straight from completing my Sc.B. in Computer Science at Brown to doing a doctorate at Carnegie Mellon, in Human-Computer Interaction (after spending a few weeks traveling around East Asia). The next five years were a whirlwind combination of intense research and intense travel – my doctoral research involved studying urban middle school students using educational software, and my travel involved backpacking in sub- Saharan Africa and in the Canadian Arctic; it's hard to say which was more of an adventure!

ABOVE Ryan Baker '00 and his wife Adriana de Carvalho, researching the sights of the United Kingdom.

BELOW Morgan McGuire's battling skeleton warriors in *Titan Quest*, published by THQ. Doesn't this make you want to register for CS123?

My education in computer science at Brown (as well as the broad and eclectic education I was able to get at Brown in general) gave me an extremely solid foundation for a multi-disciplinary doctoral thesis, at the intersection of AI, educational psychology, and interaction design. In that thesis, which sometimes felt more like three theses, I studied how students choose to use educational software (finding out which types of behavior, such as trying to "game the system," led to significantly poorer learning), developed a system that could automatically detect relevant differences in student behavior (involving some very fun work combining machine learning with psychometric models and meta-analytic methods), and developed a software agent that responded to specific behaviors associated with poorer learning and improving students' learning.

I'm now a Research Fellow at the University of Nottingham, in England, at the Learning Sciences Research Institute, where I'm continuing and expanding this program of research, toward the long-term goal of developing simulated students that can produce the full pattern of behavior that real students demonstrate in interactive learning environments, across a variety of types of learning environments, using no other information than a characterization of the interface and a concept map of student knowledge in the domain. I've also been involved in the establishment of the International Working Group for Educational Data Mining (www.educationaldatamining.org). We have held multiple workshops in this emerging area in the last two years, and plan to hold our first international conference in 2008.

Outside of work, in 2004 my travels led me to northeastern Brazil, where I met my wife, Adriana Maria Joazeiro Arruda de Carvalho, an environmental activist. We were married in a small ceremony last November, one week before I defended my doctoral dissertation. Our honeymoon, after the defense, was spent in scenic Fall River, Massachusetts. **C!**

Working on Play

Morgan McGuire accepted a faculty position at Williams College, where he's teaching a game design studio and computer graphics. He and his wife Sarah have quickly adapted to life in the Berkshires, which involves a lot of canoeing, hiking, attending concerts, and time spent in art museums. They think it is like paradise, but with mosquitoes.

Morgan's current research projects seek better entertainment through science. He's developing new cameras that perform special effects like blue-screen matting without needing a film studio. This opens effect technology to consumers and lets professionals create more innovative films. He's also developing a new method for evaluating the fun factor of a video game from a design specification, saving the cost of developing the 90% of games that fail financially.

Two video games he worked on shipped this summer. In *Titan Quest*, you battle mythological beasts on a quest through ancient Greece, Egypt, and China. *ROBLOX* is every engineer's childhood fantasy: an online world made entirely of Lego bricks. **C!**

Jon Monsarrat was a Ph.D. student from 1992-1994. He is the CEO of Activity Central and can be contacted at jonmon@mit.edu.

Aaron Cohen '75, '76 Sc.M. would like to get in touch with fellow Brown alumni. He can be contacted at aaron.s.cohen@verizon.net.

Return of the Merry Prankster

I was a Ph.D. student in computer science from 1992-1994 – you may remember me as the guy who filled Tom Dean's office with balloons or put a hot tub in front of the CIT. You can see a write-up of various Brown pranks at www.mit.edu/~jonmon/Pranks.

As I said the last time I wrote to *Conduit* a few years ago, I founded a company called Turbine Entertainment Software, www.turbine.com, which has now grown to 250 employees including many Brown-ians (Brown-ites?). Then I went back to MIT to get my MBA, completing my fall to the dark side, turning from a young padawan programmer to a master of business. I've run my own independent business consultancy, which is like being a therapist for startups. They sit on a sofa and whine about their life, and I advise them and make Freudian references, writing maybe fifteen business plans in the process.

ABOVE The complete story of the Brown hot tub prank can be found at www.mit.edu/~jonmon/Pranks. While it doesn't appear that Eugene Charniak joined Jon in the hot tub, he has signed on as an advisor to Activity Central, Jon's latest venture.

In the last couple of years, I've made a hobby out of building a list of "1000 New England Activities," which you can find at www.serpermethod.com/johnnys-activities.htm, and a weekly blog of what's coming up at make-you-laugh.livejournal.com. Working on this list led me to The Next Big Idea Since Turbine, so I am once again starting a company, called Activity Central.

The idea is to scrape event listings from museum, venue, and other websites and compile it into a huge database which I'll then sell as a newswire service to magazines and newspapers. Eugene Charniak has joined the team as an advisor and the company has a prototype and some early interest from the *Boston Globe* and the *Weekly Dig*. We're still in seed funding stage, taking chunks of $5K to $25K, so if readers have a relative/co-worker/friend with a little spare cash and a fondness for high-tech, please send them to me at www.activitycentral.org. The company was presented at the Brown Venture Forum in October www.brownventureforum.org.

Other reasons to contact me: I often mentor people with startups looking for some direction, advise on whether business school makes sense, and by Spring 2007, I'll be looking to hire programmers in J2EE, Ajax, and natural language algorithms. Zip me at jonmon@mit.edu. **C!**

Summarizing Thirty Years in a Few Scintillating Paragraphs

Thirty years ago (May 1976), with my Sc.M. in computer science pending, I had three job offers: Raytheon, a consulting contract working for Andy at Raytheon, and Bell Labs working in the UNIX Development Group (for 50% more than Raytheon or Andy were offering). When I asked Andy for his advice, he recommended, in the most colorful language, that I seek my fortune in New Jersey. I have been here for 30 years, have had two jobs, and am now seeking a third.

Now, since "True Tales from the Tech World" is not looking for a soporific to aid alumni with insomnia, I will try to summarize thirty years in a few scintillating paragraphs. As Andy used to comment as he bled red ink on Jack Stankovic's and my joint masters thesis, "shorter is better."

Bell Labs was a comfortable place to land right from school. It had a research cant and an academic feel. The small department (about eighteen people) I started with was supporting the UNIX System for internal development groups. UNIX didn't have much visibility outside Bell Labs and some university computer science programs. My first assignment was to understand the differences between our supported version of UNIX, and the version that the computer science research department (Thompson, Ritchie, Kernighan, Lesk, et. al.) were running on the "sixth floor." Eight years later, when I left the UNIX Development organization, those eighteen people had grown to several hundred occupying two entire buildings.

In 1990 I took over a custom software development shop creating applications for many AT&T clients including the NYSE and CBS TV. This continued until AT&T bought, and transferred, the computer business to NCR, an organization from the Midwest with good solid Midwest,

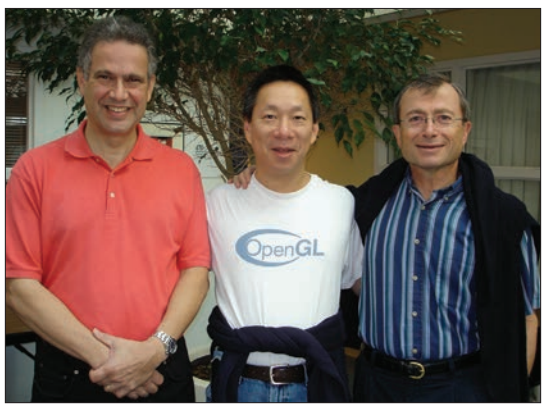
ABOVE Aaron Cohen with wife Laura at a recent MS Walk. Aaron still has the cool-looking hand-powered tricycle, but the beard is no longer – a radical change after thirty-six years!

1950s *Leave it to Beaver* values and style. I took my severance and escaped to a startup.

Unified Systems Solutions was a startup organized in 1992 by a former Bell Labs colleague and funded by Computer Horizons Corp., which bought it the following year in a four-year earn-out. We did enterprise management projects, project management consulting, and custom software development, mostly using PowerBuilder. I ended up managing the enterprise management (OpenView) and help desk (Remedy) practice. We designed and deployed network management centers and help desk systems for diverse companies, including AT&T and Dow Jones.

CHC tried to merge with another company last year to gain economies of scale and make us big enough to play in the contracting and increasingly closely managed strategic staffing market. The deal struck by the board of directors did not play well with some dissident stockholders. They voted down the merger, and subsequently voted out the board. I was laid off at the end of 2005. My severance safely in the bank, I have been doing my old job, part time, because it still needs to be done, consulting a bit, and looking for a job. Self-promotion has never been my strongest point, and I am still looking for a professional way of telling people that basically, I provide a layer of adult supervision for highly motivated people on technically intensive projects.

Life in the real world – always interesting. Everything changes, except for Andy – if the pictures in *Conduit* have not been retouched. (*Editor's Note:* Aaron, you'll have to talk to Andy about his "fountain of youth" – see the photo below for a great example – the only image editing we do is red-eye reduction.) **C!**



LEFT (left to right) Tom Doeppner, Mason Woo '75, '76 Sc.M., and Andy van Dam pose for a photo. Mason presented a guest lecture entitled, "Old and New Uses for Graphics Hardware," to the Department's Undergraduate Group (DUG) in September.

Cantrill, Shapiro, and Leventhal Win WSJ Innovation Award

Bryan Cantrill '96, Mike Shapiro '96, '97 Sc.M., and Adam Leventhal '01 – all engineers at Sun Microsystems – received the top prize in the Wall Street Journal's 2006 Innovation Awards for their work on DTrace, a new technology that diagnoses misbehaving software quickly and relatively easily, even if the cause is buried deep in a complex computer system.

Originally attracting more than 600 applications, judges from research and academic institutions selected three top award winners – Gold, Silver, and Bronze, and an Honorable Mention. This is the second time in three years that Sun was chosen as the top winner for the Technology Innovation Awards contest. **C!**

In Memory of Dan Plummer '88

Dan Plummer, of Redwood City, CA, was killed on January 1st, 2006 when he was hit by a falling tree while bicycling. A research scientist, he was a consultant for various technology companies in the San Francisco Bay Area and served on the medical faculty at UC San Diego. A champion cyclist, he raced on TeamSpine, a northern California amateur road-racing team. Originally from Massachusetts, Plummer had been cycling competitively for about ten years. Those wishing to honor Dan's memory may do so by contributing to the Dan Plummer Memorial Fund at the Walpole Scholarship Fund, 3 West Street Suite 9, Walpole, MA 02081

Information provided by Martin-James Porter, Advancement Research. **C!**

Ping!

Don't have time to write a full article? Ping! is the hyper-optimized version of "True Tales from the Tech World." Send your quick update via the form on *Conduit*'s back page or drop an email to conduit@cs.brown.edu.

Russ Ellsworth '79, '85 Sc.M.

I was recently appointed Section Manager, Engage Systems Software at Raytheon's Company Maritime Mission Center in Portsmouth RI. In March, at the 5th annual Raytheon Systems Engineering/Software Engineering Symposium, I received another "best presentation" award as voted by the over 500 attendees. This is the third year in a row that my co-author Rob Raposo and I have received one of these awards at the annual symposium (fewer than 5% of the talks receive this award!) This year it was a talk entitled "Macro- and Micro- Optimization: When Software Doesn't Fit."

Brook Conner '91, Sc.M.'94 brook.conner@morganstanley.com or home as me@nellardo.com.

I recently started a new position in software security at Morgan Stanley and celebrated the start of my third year of marriage to Allison Duda Conner (Penn '94) at Disney World on Halloween. We live in Park Slope, Brooklyn, with three small, fluffy dogs and one cat and occasionally my daughter Zooey (who, for those that remember her, is now ten, and in school at the International Charter School in Pawtucket).

Don Engel '01 Sc.M. donengel@physics.upenn.edu

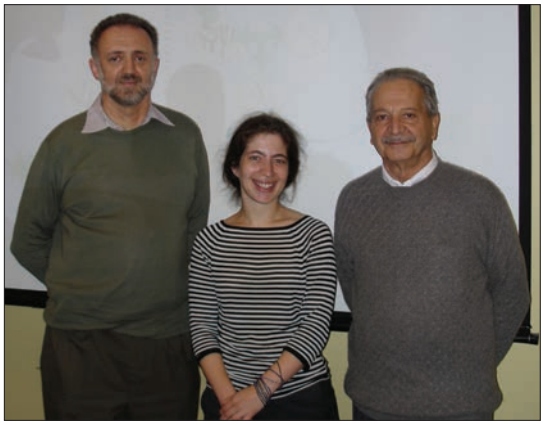
In April, I completed a Physics Ph.D. at the University of Pennsylvania. My research was in computational protein design. In September, I began a year as a Congressional Science Fellow in Washington, D.C., for which I am being sponsored by the American Physical Society.

Merri Morris '01 merrie@alumni.brown.edu

I had hoped to attend my five-year reunion this May, but the final stages of graduate school kept me on the west coast. After five years at Stanford University, my husband Dan Morris '00 and I have both just completed our Ph.D.s in computer science and will be starting jobs at Microsoft Research this fall. I'll be a researcher in the Adaptive Systems and Interaction group, and Dan will be in the Visualization and Interaction group. We're looking forward to re-connecting with classmates in the Seattle area. **C!**

ABOVE Dan and Merri Morris recently completed their Ph.D.s in computer science at Stanford University.

BELOW The Center for Computational Biology recently hosted a talk by Miriam Goldberg '03, entitled, "Evidence for Natural Deimmunization of Autologous Proteins." (left to right) Sorin Istrail, Miriam, and Franco Preparata.



Computer Science Fundraising Initiative

Support Computer Science

If you would like to contribute to the Computer Science Department's fundraising initiative, please visit www.gifts.brown.edu/ or contact:

Eli Upfal, Chair
Department of Computer Science
Brown University
Box 1910
Providence, RI 02912
401.863.7600

The Computer Science Department is embarking on an ambitious fundraising campaign that is an integral part of the university-wide Plan for Academic Enrichment. This comprehensive computer science initiative has two overarching goals:

- Supporting excellence in teaching, research, and scholarship through expanded opportunities for Brown's faculty and students.
- Renovating the Thomas J. Watson Sr. Center for Information Technology.

A Commitment to Excellence

In order to maintain Brown's excellence in Computer Science, the Department seeks two endowed professorships with which it can reward outstanding senior faculty members and attract distinguished teacher-researchers to the University. To date, Computer Science has secured one endowed chair, generously funded by friends of Professor Andy van Dam.

The department also aims to increase the number of postdoctoral positions, the number of graduate students, and its available resources so that it can continue and expand its cutting-edge work in a variety of areas. Graduate students are involved not only in the department's research and teaching activities, but also in helping chart its course. They serve on several important committees and help organize seminars and lunches as well as recruiting and orientation events. Their experience and curiosity bring invigoration to the department and create another level of support for undergraduates.

In addition to faculty work and graduate student training, Brown's Computer Science Department also places equal emphasis on maintaining the quality of its highly ranked undergraduate programs. Members of the department understand that a top-notch faculty and exciting learning opportunities will attract the most promising undergraduate students to the computer science program.

Renovating the Thomas J. Watson Sr. Center for Information Technology

When it opened in 1988, the award-winning Watson Center for Information Technology housed both the Computer Science Department and Brown's Computer Information Services. In 2004, the University moved Computer Information Services to another location and dedicated the full space in the Watson Center to the Computer Science Department. The space has been redesigned to accommodate multidisciplinary research groups and students in related concentrations who must collaborate on projects.

The renovation, estimated at a total cost of $2.5 million, enhances every aspect of computer science education at Brown. It opens space on the 3rd, 4th, and 5th floors for modern technology and classrooms. Specifically, the renovation includes a state-of-the-art motion-capture laboratory, an algorithms laboratory, an Internet laboratory, and two systems laboratories.

The work also creates modern, integrated office space for new faculty, staff, graduate students, and undergraduate teaching assistants. In keeping with the notion of a community of collaboration, the faculty, staff, and student offices are now intermixed and open onto lounges and meeting areas. The meeting and study space in the building has also been expanded to promote faculty and student interaction. The redesigned space contains group working areas, comfortable chairs, large tables, and whiteboards for idea sharing. Refurbished conference space for symposia and graduate and undergraduate functions also contribute to increased collegiality.

A gift to the Computer Science Department's fundraising initiative will directly benefit the faculty members and students who drive the ongoing, innovative work in this discipline. Support for this priority also goes straight to the heart of Brown University's overall mission—to foster the intellectual and personal growth of our students and to collaborate on solutions to problems that affect our neighborhoods, our nation, and the world. **C!**

Alumni Happenings

Reunion 2007

Be sure to save Saturday, May 26th for the 3rd annual Computer Science Reunion and Networking Reception!

Join computer science alums, faculty, and friends from 5-7 p.m. on Saturday, May 26th. Enjoy a live jazz band, delicious hors d'oeuvres and beverages, and engaging conversation while touring the beautifully redesigned CIT 3rd and 4th floors. Last year's event was an enormous success, so be sure to include us as part of your Commencement and reunion plans!

Alumni discussion and networking groups

Join the CS discussion groups and stay in touch with each other and the department. "Lubrano" is a moderated e-mail announcement list promoting employment opportunities, professional development, and continuing education offerings.
To learn more and subscribe, visit:
http://groups.yahoo.com/group/cslubrano/

"CS Atrium" is an unmoderated networking and discussion forum promoting professional and personal communication among alumni. Conversation is not limited to technical matters!
To learn more and subscribe, visit:
http://groups.yahoo.com/group/CSAtrium/

Visit the Department's website

Please be sure to visit the Computer Science Department's website at www.cs.brown.edu. The site, which is frequently updated, provides easy access to Department-related news, events, and research.

Conduit wants your stories!

If you enjoy reading *Conduit*, you'll have even more fun writing for *Conduit*! Your stories, research, news, and photographs are always appreciated. If you have ideas, suggestions, or would like to contribute, please contact Laura Zurowski at conduit@cs.brown.edu.

The second annual Computer Science Reunion and Networking Reception was a big success and destined to become a reoccurring Commencement event. But be warned... reunion attendance may result in your photo being used on future invitations (or, for that matter, in the pages of this publication!)

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? Use this form to submit your news or email conduit@cs.brown.edu.

First Name

Last Name

Class Year

Address

City

State

Zip

E-Mail

My news:

Mail to: Conduit, Department of Computer Science, Brown University, Box 1910, Providence, RI 02912

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