Conduit

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

A Visit to Al Quds University

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Notes from the Chair: the Latest News from 115 Waterman

Greetings to all CS alums, supporters and friends.

We are well into the second semester of the year and are as busy as ever. Fantastic things continue to happen in the department and I am thrilled to be able to share some highlights with you.

The first few months of the year brought several honors to our faculty. Congratulations are in order to Ben Raphael, who was recently awarded the prestigious Sloan Research Fellowship for his work on developing novel computational and mathematical approaches to problems in biology, especially cancer genomics and comparative genomics. Besides his Sloan Fellowship, Ben has previously received other recognitions for his work, including a Career Award at the Scientific Interface from the Burroughs Wellcome Fund.

I'm also delighted that the Association for Computing Machinery (ACM) recently elevated Tom Dean to Fellow for his development of dynamic Bayes networks and anytime algorithms. Tom, who was a faculty member in the department from 1986 until 2007 and served as department chair from 1997 to 2002, is currently a staff research scientist at Google, Mountain View, and maintains an adjunct professorship here at Brown. His research accomplishments include work on the role of prediction in planning, control and decision-making where uncertainty and the limited time available for deliberation complicate the problem. His temporal Bayesian networks, later called dynamic Bayes networks, made it possible to factor very large state spaces and their corresponding transition probabilities into compact representations, using the tools and theory of graphical models. Tom joins the department's seven other ACM Fellows: Maurice Herlihy, Franco Preparata, John Savage, Eli Upfal, Andy van Dam, Peter Wegner and Stan Zdonik.

I'm pleased to announce that Brown University and the National University of Singapore (NUS) have established a concurrent computational biology degree program. Students who complete the program will receive concurrent degrees from NUS and Brown: a bachelor's degree in computational biology from NUS and a master's degree in computer science with a special designation in computational biology from Brown. Franco Preparata, who has been a visiting faculty at NUS for several years, is the primary architect of this program at Brown. Tom Doeppner has also been involved in setting up the program. Thanks to both Franco and Tom for their leadership in developing this exciting new program.

In other news, the second year of the department's Distinguished Lecture Series was quite a success! This year's lectures were given by Michael Goodrich, University of California, Irvine (October 20), Michael Littman, Rutgers University (October 29), Renee J. Miller, University of Toronto (March 4), Joel Emer, Intel (March 11), Jennifer Chayes, Microsoft Research (April 8), Jeannette Wing, Carnegie Mellon University and National Science Foundation (April 19), Rob Schapire, Princeton University (April 22), and our own John Savage (April 29), who gave a Special 70th Birthday Lecture.

The Distinguished Lecture Series also included the Ninth Annual Paris C. Kanellakis Memorial Lecture, which was delivered on December 3, 2009 by John C. Mitchell of Stanford University. This year's Kanellakis Lecture was particularly special since Dr. Mitchell was a close friend of Paris's as well as a research collaborator.

It is with great sadness that I share the news of the passing of General Kanellakis in late January, at the age of 97. I was lucky enough to spend a day with General and Mrs. Kanellakis at their home in Athens, Greece in September 2008, when they shared with me and Ph.D. student Babis Papamanthou memories of Paris and his family, as well as an extensive archive of documents about Paris's professional life. I was struck by the warmth, generosity and intellect of General Kanellakis and know that he will be truly missed by the department. Our thoughts are with Mrs. Kanellakis during this difficult time.

Turning to the future, I look forward to seeing you at the next Computer Science Reunion on Saturday, May 29, 2010. We encourage all alums, friends and supporters to stop by. Please register for the reunion at www.cs.brown.edu/events/reunion/home.html

Finally, we urge you to contribute your professional and personal stories for inclusion in upcoming issues of Conduit. Your support of and participation in department activities is always appreciated and we are grateful to have such a tight-knit community— thank you!

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

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A Visit to Al Quds University in the Palestinian territories

By Claire Mathieu

The Holy Land is a special place for me. It is the country of many of my friends and colleagues in the academic world, and of my religious roots. But virtually everyone I know there is Jewish Israeli. What about Arab Israelis, and what about Palestinians? I was curious to meet them, so as to give a concrete reality to their existence, and to be able to associate faces of real people to the abstract "Palestinian population" sometimes mentioned in the news. On the occasion of a trip to the Hebrew university of Jerusalem in December 2009, I arranged to give a seminar at Al Quds university in the Palestinian territories.

One Saturday morning, my driver, a short man with a mustache, picks me up in the hotel lobby. I climb into his light, unmarked truck, and off we go, him driving silently around the Old City and away into the mountains, me wondering where we are headed and feeling a little bit nervous. The campus of Al Quds is in Abu Dis, a few miles from Jerusalem. Since the wall has not yet been built across the road we take, the only barrier we pass on the way is a small roadblock on the other side of the highway. I watch the dry mountainous landscape and the Middle-Eastern towns, noticing a good number of construction projects and of brand new buildings. In one valley, we pass a "USAid" sign mentioning some water project. We may be in a developing nation, but international help does seem to be arriving!

Once at Al Quds university, my host greets me in the very modern information technology center and takes me for a tour of campus, followed by a woman introduced as the person in charge of "public relations." She hardly says anything all day, but, because of her presence, I never have a one-on-one conversation with any one; is it chaperoning or a discrete surveillance? I am not sure. The campus is sunny and very pleasant, and everything is neat and well-kept. We hear the gentle sound of water trickling from the fountains. Scattered groups of students are chatting, studying or relaxing on the stone benches under the olive trees. Most of the women wear colorful silk scarves, and the peaceful scene would look idyllic, if my Western mind didn't remind me that scarves are supposed to be a symbol of oppression of women. Throughout my visit, to mark their deference for their guest, my companions are constantly stepping aside to let me go first through doors and lead the way, hence a rather complex ballet of foot movements. I am not used to such manners and it is a bit awkward for me, especially since I usually do not know which direction we are supposed to go next! I can only hope I haven't committed any serious breach of etiquette; if I have, my hosts are too polite for me to be able to tell.

After meeting the dean of science, we go to visit the "museum of political prisoners" where I see a map of prisons (interestingly, I note that the 1967 borders

are drawn on the map) and documents about Palestinians in Israeli prisons: photos, art created by prisoners, letters to family members. Although I try to keep in mind that this is one particular perspective of the conflict, it is rather striking. Previously, I had suggested to an Israeli pacifist-leaning friend that he, too, might wish to visit there, but now I am having second thoughts about that idea. It is one thing to want to be a peacemaker and wish to talk with people of goodwill on the Palestinian side, but quite another to watch an exhibit detailing exactions committed by one's fellow countrymen! We then meet the director of the museum, who offers me a cup of tea. Since he does not speak English, my host translates. He gives me various statistics. I ask: "How do you see the future?" What a question! A deluge of words follows, summarized by the first sentence: "The future is dark." I ask my host: "Do you have any students who have been to prison?" He smiles at my naïveté: "Yes, of course," and then proceeds to give me an extraordinary quote: "Prison is a flower that every young Palestinian has to smell!" I am stunned. But he adds immediately that, as for himself, by good luck he has never gone to prison so far.

The wall is there, tall, dark, forbidding. It stands right next to the campus entrance, winds down into the valley and goes back up to block the horizon on the hill facing us. Its presence is a constant reminder of the political situation. No more rational reasoning on statistics, no more careful weighing of objective pros and cons: I am pained by its ugly, intrusive sight.

I give a talk to an audience of a dozen students and faculty, in a well-equipped room. There are a few comments, including one by a woman with a scarf, in the back of the room: bravo! People seem interested to learn how search engines (such as Google) auction their ad slots, and I get some good questions. We then have lunch in a restaurant on campus. I am surprised to learn that in Computer Science the majority of the students are women. Apparently, this phenomenon can be traced back to the first intifada, when many young men went into hiding. In addition, the women also tend to get better grades, but after graduation their salaries are much lower than men's - hardly a surprise. Most graduating students go on to teach, although low salaries often require teachers to take on a second job. We discuss the problems of education at the primary and secondary levels, entirely based on rote learning and from which creative thinking is completely absent. Al Quds was the first university with a computer science department. I ask: does it

have the best computer science students? Not necessarily. Because of the difficulty of traveling and going through checkpoints that risk causing delays of several hours, students tend to choose their university according to accessibility. Hence Ramallah students tend to go to Bir Zeit, whereas Al Quds attracts students from the neighboring region. Most students are self-supporting and work full-time, so they only study part-time, one or two days per week, and naturally that delays graduation by years. There are undergraduate and masters students (no Ph.D. program). Among the faculty, some hold a masters and some have a Ph.D. I am told that one is working towards a Ph.D. in Math at the Hebrew university, and another is doing a Ph.D. in education at the Weizmann institute.

What do they need? They have long-term plans of reforming the high-school curriculum, with the introduction of problem-solving and of mathematical competitions, once teachers become receptive to the idea. They are very interested in e-learning and have had contacts with CNAM in France on the subject. They are looking for scientific collaborations with opportunities for visits, student exchanges, etc. They wish to introduce their masters students to research and would welcome long-distance co-advising on research projects, suggestions for good research topics, and other ways to help them develop their research. In short, these are the natural priorities of faculty who wish to better educate the youth of their country and foster advanced learning. In a way, in spite of the adversarial context they sound more optimistic about the future than the Israelis I have talked to!

We wait for my return taxi, standing near the wall that once again takes center stage. My host tells me that his sister, being married to a Jerusalemite, now has an Israeli ID that makes it difficult for her to cross the checkpoints into the Palestinian territories. "She was born here and wants to come and visit her mother who still lives here. How can it be that the border patrols don't want to let her through, for her to see her own mother?" he sighs. But he carefully refrains from following up with political statements.

As for me, when the taxi crosses the checkpoint I am simply waved through and, just like on my trip to Bethlehem, no one even looks at my passport. For a tourist like me, the borders are wide open!

In academia, we like to believe that in the long term education cures all problems. The Israeli-Palestinian conflict is much too complex for outsiders like me to even begin to gauge but, where there are students trying to learn and professors trying to teach and to develop a knowledge of research, how can it not be a good idea to try to participate towards their general goal of academic learning?

The Kanellakis Legacy Lives On

Edited by PCK fellows Yola Katsargyri (MIT) and Nikos Triandopoulos (Brown). Special thanks to Manolis Kellis and Amy Tarbox for their help.

It is with great sadness that we announce the passing of General Eleutherios Kanellakis, Paris's father, on January 27, 2010 at the age of 97.

Paris Kanellakis was a distinguished computer scientist and an esteemed and beloved member of the Brown Computer Science Department. He joined the Department in 1981 and was promoted to the rank of full professor in 1990. His research area was theoretical computer science, with emphasis on the principles of database systems, logic in computer science, the principles of distributed computing and combinatorial optimization. He died in an airplane crash on December 20, 1995, along with his wife, Maria Teresa Otoya, and their two young children, Alexandra and Stephanos.

Eleutherios Kanellakis was born in the area of Corinthos in Peloponnesus, studied Law at the University of Athens and worked as magistrate in the island of Ikaria. During World War II he joined the Greek army as a reserve officer who participated actively in the efforts liberating Greece, where he received many distinctions. In 1942, he left occupied Greece to join the Greek Forces in Minor Asia. From 1947 he served as a supreme officer in the Military Department of Justice of the Greek Air Forces, where he built a long career with many distinctions. He completed a two-year masters degree in "Penology and Crime" at the University of Michigan, where he published a book on his thesis. For many years he taught Constitutional and Governance Law in the Military School of the Greek Air Forces, and published many books. He spoke five languages.

Overcoming the tragic loss of their only son, General and Mrs. Kanellakis established two graduate-student Fellowships in his memory in 1998, one at Brown and one at MIT, where Paris earned his doctoral degree. Since then, the Kanellakis Fellowship has been received by 26 Ph.D. students at both institutions. Many members of the Brown Computer Science Department and all the Fellows developed a strong relationship with General and Mrs. Kanellakis and have visited them during trips to Greece. General Kanellakis was particularly happy to see the Fellows making progress in their careers, having Paris's academic legacy as an excellent example. Up until very recently, General Kanellakis had been consistently maintaining an archive with Paris's accomplishments, and last September he offered this archive to our department. This book is available for anyone to see in the Department Chair's office.

General Kanellakis's funeral was held on January 28th at the Papagou Cemetery in Athens. Funeral wreaths were sent on behalf of the CS Department and the Kanellakis Fellows at Brown and MIT. Fellows Aris Anagnostopoulos (Ph.D. 2006, Brown), Christos Kapoutsis (Ph.D. 2006, MIT) and Ioannis Tsochantaridis (Ph.D. 2005, Brown) attended the funeral. In addition, the CS department provided financial support, in honor of the memory of General Eleutherios Kanellakis, to the Hellenic Student Association of Brown for their Greek Orthodox Easter celebration.

Paris C. Kanellakis Fellows

General Kanellakis's vision to help young scientists through a graduate-student fellowship in honor of Paris has certainly come true. The list of PCK Fellows is already long and increasing. Current students are making good progress in their graduate programs and already graduated students are pursuing successful careers as research scientists and faculty in research labs and academia.

Brown

1997–1998	Emmanuel Manos Renieris
1998–1999	Ioannis Tsochantaridis
1999–2000	Costas Busch, Emmanuel Manos Renieris & Ioannis Tsochantaridis
2000–2001	Aris Anagnostopoulos, Nikos Triandopoulos
2001–2002	Aris Anagnostopoulos, Nikos Triandopoulos
2002–2003	Olga Papaemmanouil
2003–2004	Christos Amanatidis, Alexandru Balan
2004–2005	Aris Anagnostopoulos, Tomer Moscovich, Nikos Triandopoulos & Yannis Vergados
2005–2006	Aris Anagnostopoulos
2006–2007	Daniel Acevedo Feliz, Glencora L. Borradaile & Eric Ely Rachlin
2007–2008	Charalampos Papamanthou
2008–2009	Aggeliki Tsoli

The Department has nominated Foteini Baldimtsi for the 2009–2010 Kanellakis Fellowship.

MIT

1999–2000	Manolis Kamvysselis (Kellis)
2000–2001	Christos Kapoutsis
2001–2002	Aristidis Karalis
2002–2003	Christos Christoudias
2003–2004	Anastasios Sidiropoulos
2004–2005	Nikolaos Andrikogiannopoulos
2005–2006	Apostolos Fertis
2006–2007	Georgia-Evangelia Katsargyri
2007–2008	Georgios Papachristoudis
2008–2009	Vasilios-Marios Gkortsas
2009–2010	Georgios Angelopoulos

MIT: Manolis Kellis, Georgios Angelopoulos, Georgia-Evangelia Katsargyri, Georgios Papachristoudis
Brown: Olga Papaemmanouil, Aggeliki Tsoli, Nikos Triandopoulos, Foteini Baldimtsi, Charalampos Papamanthou, Yannis Vergados, Aris Anagnostopoulos
(Also in the picture: 5 friends of the Fellows.)

Paris Kanellakis Fellows Meet

By Yola Katsargyri, MIT PCK Fellow

Two years ago the Kanellakis Fellows from both Brown University and MIT took the initiative to organize a dinner and meet each other. The dinner was hosted by Manolis Kellis, who, being one of the first fellows, brought us all together and tried to inculcate in our minds the idea of the Kanellakis Fellows family. Although some of us were meeting for the first time, it only took a few hours to realize that we were not just a few people who happened to have received the same fellowship. Paris's short life and General and Mrs. Kanellakis's generosity and courage bonded us strongly.

In 2009, the second PCK Fellows dinner was organized by Nikos Triandopoulos and Olga Papaemmanouil. They warmly offered their home as a place to reconnect and also welcome the new members to the Kanellakis Fellows family. This dinner provided the opportunity for the Fellows to share creative ideas that aim at further preserving the PCK Fellowship and the memory of Paris, such as creating a Kanellakis Fellows webpage and organizing a yearly scientific symposium for Ph.D. students in memory of Paris, among others.

The parental love that we all received from Eleutherios and Argyroula Kanellakis was a strong incentive for the Fellows to support each other and to form a strong community that keeps Paris's memory and legacy alive for the years to come.

Ninth Annual Paris C. Kanellakis Memorial Lecture

On December 3, 2009, John C. Mitchell of Stanford University delivered the Annual Paris C. Kanellakis Memorial Lecture. This lecture series has been held annually by our department in honor of Paris on or around his birthday. In a standing-room only lecture, Prof. Mitchell kindly devoted a long introduction to Paris, describing their close friendship, as well as two articles that they coauthored. The talk, titled "Safety on the Wild and Wooly World-Wide Web: Sandboxing Untrusted JavaScript" outlined some of the practical security problems that have arisen in recent years as a result of combining trusted and untrusted content and described several methods for solving these problems. A reception followed the lecture, where Prof. Mitchell met PCK Fellows from Brown and MIT and spent time talking with them, sharing memories of Paris and providing advice for successful completion of Ph.D. studies.

Storytelling About Lighthouses:

When Professor Dijkstra Slapped Me in the Quest for Beautiful Code

By **Sorin Istrail**

*** Arrogance in computer science * Empirical science? * Philosophy * Goddess Reason * A Critic's Dilemma * Pajamas algorithms * Pastiche pie prize**

THE SLAP

I finally met E.W.Dijkstra, the brilliant computer scientist whom I had admired for years, in Newport, Rhode Island. It was 1986, three years after my immigration to the United States from Romania, and Dijkstra, by then the Schlumberger Centennial Chair in Computer Sciences at the University of Texas at Austin, had invited me to join him for a day at the Summer School on Program Construction being held at Salve Regina University.

The day alternated between Professor Dijkstra lecturing and writing on a blackboard with his exquisitely precise handwriting. (Even now, I can recall how he returned to the blackboard to redraw a capital letter M that he felt lacked parallel vertical lines.)

At lunch, he sat near me at a long table with about ten others. Everybody there was eager to hear what this master would say, and because he spoke softly, few people if any were talking. We had just about finished eating when Dijkstra raised his voice to address me.

"Sorin - I have a problem for you."

"Sure," I said, thinking that this was the moment I had been waiting for since 1983, when I first solicited Dijkstra's comment and guidance on a technical report I had sent him previously.

The silence at the table became more pronounced.

"If 10 years from now, when you are doing something quick and dirty, you suddenly visualize that I am looking over your shoulders and say to yourself: 'Dijkstra would not have liked this.' well that would be enough immortality for me." [1]

Edsger Dijkstra

"Suppose we play a two-player game played with identical coins on a table," Dijkstra began. "We have a bag of coins with as many as we need. The two players alternatively take a coin from the bag and place it on the table. The rules of the game forbid the coin to sit on top of another coin on the table, but it could hang off the table as long as it does not fall off. The player who puts the last coin on the table wins the game."

There was something in Dijkstra's expression – a combination of smile and an intense Don Quixotesque gaze – that seemed to raise the stakes at the table. I awaited *the* question.

"Is there an algorithm for one of the players to win always?" he asked with the quiet, calm assurance of a man who saw it all, who knew what would happen next.

I said nothing for a minute or two, anticipating the excitement that was to come. Then, as if jarred awake from a pleasant dream, I did what one does in such a moment: With my right hand, I reached down the neck of my sweater to remove a pen from my shirt pocket.

My hand was not even halfway there when – slap! Dijkstra smacked my hand away from its goal. Those few seconds that followed were long but I was slow to figure out, and I could not believe the strength of the slap. Instinctively, I drew away from him and the others at the table recoiled.

Dijkstra broke the silence. "Don't mess up your thoughts," he proclaimed. "Keep it simple, in your head."

It goes without saying that for the next few minutes I was useless at solving the puzzle and I bubbled nonsense. He waited a bit, then began offering clues. "Did I tell you anything about the table?"

"No," I responded. I began to think out loud. "As it must be true for all tables ..."

He interrupted with a question. "What is the smallest table?"

"One point?" I said trying to recover.

"Who wins then?" he asked.

By now rational, I responded. "The first player. So the first player always wins."

"Which table to consider next?"

"As big as a coin; again first player wins." I thought I was on a roll.

"No."

Me: "How about as big as two coins?"

Dijkstra: "Yes. Who wins then?"

Me: "First player puts his coin in the middle of the table. And I am not sure if the second can put his coin, but if the second can, so can the first again symmetrically; if not, neither can ... so first wins again!"

Dijkstra: "Do you have the algorithm now?"

Me (excitedly, knowing what he wanted to hear): "The invariant is Every point on the table, except the center, has a symmetric point with respect to the center."

Dijkstra: "Bravo."

(To translate the answer into *Dijkstranese*: The first player always puts his first coin on the center of the table. The second player puts his coin somewhere on the table that is free, and then the first player makes his move in exactly the symmetric point to the center, which is always free by the *invariant*. And so on, *mutatis mutandis*. The invariant assures the correctness of the algorithm no matter how many moves/how big the table.)

One of the Joys of Life and the Cruelty of Really Teaching Computing Science

Dijkstra was our Professor-in-Chief. How to teach computing science was one of the most fascinating life-long themes of reflection for Dijkstra. He wrote many articles about teaching methodology, he was the patriarch of posing beautiful problems and silly games, which gave him the opportunity to teach the art of problem solving. His algorithms, solutions of his games, define beautiful code, raising the derivation of the code from the program specification to an art performance. Those are not just beautiful games; they go to the heart of the difficulty of programming methodology, and illuminate hard-to-grasp complexities. It is an art form to invent such silly games; this art form should be encouraged and rewarded. They make the perfect opening of a lecture on the subject, especially because they satisfy the right axioms: unique solution, simplicity of algorithmic solution and rational step-by-step derivation of algorithm, generalizations become extremely difficult problems (try the above silly game with coins on a convex table), and most of all, your can find their solution without pen and pencil, in your head. I had the pleasure of attending some of Professor Dijkstra's lectures, to be trained one-on-one in the art, to have read many of his articles on teaching computing science, and to be inspired to uncover and present silly games occuring in everyday life, although their lessons are not as beautiful and important as those concocted by the Master of Silly Games. For the younger generation, here is a list of some his gems: the dining philosophers, the elephant made of mosquitoes humming in harmony, the toilet and trains, the plateau problem, the self-stabilization problem, average page fault frequency problem, the Dutch national flag, banker's algorithm, [the cryptographic game from[EWD 666]"a problem solved in my head."

Dijkstra examined radical innovation in teaching, and his thesis is always that universities should have guts in teaching.

> *"Teaching to unsuspecting youngsters the effective use of formal methods is one of the joys of life because it is so extremely rewarding. Within a few months, they find their way in a new world with a justified degree of confidence that is radically novel for them; within a few months, their concept of intellectual culture has acquired a radically novel dimension. To my taste and style that is what education is about. Universities should not be afraid of teaching radical novelties; on the contrary, it is their calling to welcome the opportunity to do so. Their willingness to do so is our main safeguard against dictatorships, be they of the proletariat, of the scientific establishment, or of the corporate elite." E. W. Dijkstra [2]*

In his "How do we tell truths that might hurt" [3] Dijkstra wrote that *"it is practically impossible to teach good programming to students that have had a prior exposure to BASIC: as potential programmers they are mentally mutilated beyond hope of regeneration"* and that *"the use of COBOL cripples the mind; its teaching should, therefore, be regarded as a criminal offense."* Computer science faculty might consider such statements dramatic, insulting, even ridiculous, but I learned from a colleague that Dijkstra refused to accept students in his class if they had been exposed to BASIC or COBOL.
This, as well as his incorporation of "radical novelties" such as solving a problem without pencil or paper may help you understand the "cruelty" Dijkstra referred to in EWD1036.

Dijkstra was nothing if not consistent, holding himself to the same standards he held others.

He arrived at his most famous algorithm, known as The Shortest Path, in his head "while I had a cup of coffee with my wife on a sunny café terrace in Amsterdam," he has said.

> *"The algorithm for The Shortest Path was designed for the purpose of demonstrating the power of ARMAC at its official inauguration in 1956, the one for The Shortest Spanning Tree was designed to minimize the amount of copper in the backpanel wiring of the X1. In retrospect, it is revealing that I did not rush to publish these two algorithms: at that time, discrete algorithms had not yet acquired mathematical respectability, and there were no suitable journals. Eventually they were offered in 1959 to Numerische Mathematik in an effort of helping that new journal to establish itself. For many years, and in wide circles, The Shortest Path has been the main pillar for my name and fame, and then it is a strange thought that it was designed without pencil and paper, while I had a cup of coffee with my wife on a sunny café terrace in Amsterdam, only designed for a demo ..." E.W. Dijkstra [4]*

He also believed that solutions could – *should* – be elegant, and that elegance could prove elusive if a programmer's first step is to reach for a pen or pencil. (A 10 years earlier explanation of a future "slap":)

"I observed a few years ago that the moment at which mathematicians introduce avoidable complications very often coincides with the moment that they resort to such mechanical aids as pencil and paper," Dijkstra wrote in "A problem solved in my head." [5]"It was then that, for the sake of clarity of my own thinking, I decided to be less liberal with the use of pencil and paper and not to use them when I could avoid using them."

"ARROGANCE IN COMPUTER SCIENCE IS MEASURED IN NANO-DIJKSTRAS"

Alan Kay 1997

"Arrogance in computer science is measured in nano-Dijkstras," computer scientist and Turing Award winner Alan Kay said during his 1997 OOPSLA keynote. The quip, which produced a roar of laughter from the audience, and his ensuing criticism of Dijkstra is preserved on YouTube.

I listened carefully to the YouTube video, I found Kay to be far from eloquent. He began his keynote with an anecdote:

"He [Dijkstra] once wrote a paper of the kind that he liked to write a lot of which had the title 'On the fact that the Atlantic has two sides' [EWD611] and it was basically all about how different the approaches to computing science were in Europe, especially in Holland, and in the United States. In the U.S. here, we were not mathematical enough and, gee, in Holland, if you are a full professor you were actually appointed by the queen, and there were many other important distinctions made between the two cultures.

"So I wrote a rebuttal paper and it was called 'On the fact that most of the software was written on one side of the Atlantic,' and it was basically about – 'cause I have a math degree, too – that computers formed a new kind of math … they don't really fit well into classical math… It was about a kind of practical math. The balance was between making structures that were supposed to be consistent of a much larger kind than classical math had ever come close to dreaming of attempting, and having to deal with the exact same problems that classical math of any size has to deal with, which is being able to be convincing about covering all the cases." [6]

Defending "Arrogance"

Your Honor, ladies and gentlemen of the jury, Professor Dijkstra is accused of "arrogance."

Well, it is well know that at times, Professor Dijkstra expressed his strong opinions with critical irreverence, infuriatingly insensitive, but always with eloquence. To cite some extremes, he called the great logician Bertrand Russell a "dilettante" regarding his mathematical notation, accused John von Neumann of bringing (contra-productive) anthropomorphic terminology to computer science inspired by his work on the brain as "medieval speculations", and one of his favorite tirades against Software Engineering, coined "the Doomed Discipline," and even harshly, "How to program if you cannot." Even more extreme, he recommended that students in introductory programming courses should be prevented from the temptation to execute their programs, as they should be taught through mathematical logic to infer the correct program hand in hand with their proof of correctness.

Despite these points of view, I believe that some of these extremes were part of his dramatics, theatrical, and sometimes humorous avenues to deliver a forceful message for change, a poke in the eye for those asleep at the wheel, about the need to breakthrough deadlock, and the need to be bluntly honest. A model of "how to say truths that might hurt." A number of his critics address these extremes of his writings as if they are his entire position

Professor Dijkstra was indeed arrogant but about honesty, about the programming elegance, and about radical novelties in education. Even if extreme, I still prefer his Don Quixotesque exceedingly demanding goal of "logic proof" as science-base driving force, to the faith-based "every program has bugs" convenience. John von Neumann used to say that it is easier to explain science with god than without god.

I would argue that Professor Kay's and Professor Dijkstra's points of view are at the two at extremes; "not really fond of mathematics in programming" vis-à-vis of the de-empiricization of programming "craftsmanship" through mathematics towards the science of programming.

Although the two have pursued magnificent bodies of work that inspired many, they disagree in ways which have nothing to do with "truth." They each have been forcefully articulating their own philosophy and there is nothing wrong with that. On the contrary, philosophical discourse is a must when dealing with things as complex as Computing Science. Who wants to talk about the obviously neglected empiricism in specifying requirements of large codes, a really embarrassing subject? What is then a programmer to do?

In what follows, I will argue the Dijkstraian quest for programming de-empirization though mathematics. And to bring home the point I want to make about bringing philosophy out of the closet in computing science, I will go though an irreverent, and infuriating to some, tour of the principles of philosophy using the writing of the great mathematician Gian-Carlo Rota. The "axioms" formulation are my attempt to present Rota's argument and to show how relevant philosophy is to addressing the bottlenecks and failures in the software design of large systems, e.g., "Inevitability of failure" or the "Myth of precision" or the "Dictatorship of definitiveness."

I believe that if you choose to critique someone as eloquent as Dijkstra, you must at least strive to do so in a similar vein. It is probably unfair to ask someone to match Dijkstra's eloquence. Few can. But as Dijkstra offers this view about non-principle based criticism: "I love to be corrected. (Besides being a most instructive experience, being corrected shows that the other one cares about you.) If, however, they only get infuriated because I don't play my game according to their rules, I cannot resist the temptation to ignore their fury and to shrug my shoulders in the most polite manner. ... I have come to the conclusion that there are such things as 'disabling prejudices.'" [7]

In fairness, it is hard for me to believe that Professor Kay's piece recorded on Youtube, with its ramblings and profanity was part of a prepared text for his Keynote. Probably what happened was his delivery got emotional, and then inarticulate; "disabling prejudices" indeed! I see this as a sign of a deeper problem in computer science, called by some *The Software Crisis*.

Is Computer Programming an Empirical Science?

Reflecting on the nature of computing science, in general, and programming in particular, one needs to focus on the empirical aspects, mostly belonging to the software engineering focus of the discipline, as well as on the work towards the de-empirization of programming, via mathematical sciences.

John von Neumann talked about the de-empirization of the natural sciences with the exquisite clarity of his writing. He presented it by talking about the double face of mathematics. "The most vitally characteristic fact about mathematics is, in my opinion, its quite peculiar relationship to natural sciences, or, more generally, to any science which interprets experience on a higher than purely descriptive level." [8] He gave two such glorious examples: one being Geometry and the other Calculus which both started as natural, empirical sciences. Then its de-empirization happened by the mathematical method. "Some of the best inspirations of modern mathematics (I believe, the best ones) clearly originated in the natural sciences. The methods of mathematics pervade and dominate the "theoretical" divisions of natural sciences. In modern empirical sciences it has become more and more a major criterion of success whether they have become accessible to the mathematical method or to the near-mathematical methods of physics. Indeed, throughout the natural sciences an unbroken chain of successive pseudomorphoses, all of them pressing towards mathematics, and almost identified with the idea of scientific progress, has become more and more evident. Biology becomes increasingly pervaded by chemistry and physics, chemistry by the experimental and theoretical physics, and physics by the very mathematical forms of theoretical physics… One has to realize this duplicity, to accept it, and to assimilate it into one's thinking of the subject. This double face is the face of mathematics, and I do not believe that any simplified, Unitarian view of the thing is possible without sacrificing the essence."

Von Neumann's deep questions about the nature of intellectual work in mathematics can serve as a guide into our analysis of computing science: Is computing science an empirical science? Or, more precisely: Is computing science actually practiced in the way in which an empirical science is practiced? Or, more generally: What is the computing scientist's normal relationship to his subject? What are the criteria of success, or desirability? What influences, what considerations, control and direct his effort?

Dijkstra addressed these questions in his writings. In "Craftsman or Scientist?" [9] Dijkstra discusses the two extreme techniques in teaching programming. At one extreme is the "craftsmanship style," similar to the work of the future craftsman joining a master and "learning by osmosis, so to speak, the skills of the craft … a well-guarded secret." At the other extreme is the "scientist style." The future scientist learns from a teacher who formulates knowledge and skill as explicitly as possible through free interchange of knowledge and insights – "being non-secretive is one of their rules of professional conduct." A physician and a physicist, respectively, are examples of people who, more often than not, practice the two styles.

However, "mathematicians are somewhere in between: mathematical results are published and taught quite openly, but there is very little explicit teaching on how to do mathematics, and publishing besides the results also the heuristics that led to them is regarded by many as 'unscientific' and therefore, bad style: quite often the editor's censorship will try to prohibit their publication."

Dijkstra asks: *"Where along this scale should we place the teaching of programming?"*

Twenty-two years before Kay's 1997 comment, Dijkstra charmingly alluded to coming trouble: *"To make implicit knowledge explicit … we should realize that changing a craft into a science, and making public property of the secret knowledge of the guild, will always cause the guild members to feel threatened. For many a 'puzzle-minded' virtuoso coder of the early sixties, the [recent] scientific development … has been most unwelcome. … He feels like the medieval painter that could create a masterpiece whenever his experience enabled him to render proportion well, who suddenly found himself overtaken by all sorts of youngsters, pupils of Albrecht Dürer and the like, who had been taught the mathematical constructions that were guaranteed to surpass his most successful, but intuitive renderings. And with nostalgia he looks back to the good old days when his experience and feeling made him an outstanding craftsman. And we should realize that, as far as programming is concerned, the battle is still going on. – "craftsmen" [proposals] … had a pronounced anti-intellectualistic flavour: it stressed that students should be taught how to solve the problems of 'the real world' and that, therefore, the curriculum should pay as little attention as possible to 'abstract subjects.'"*

Dijkstra advocated a blending of the two teaching styles. The "disastrous blending, viz. that of the technology of the craftsman with the pretence of the scientist" is not the solution because "the craftsman has no conscious, formal grip on his subject matter, he just 'knows' how to use his tools. If this is combined with the scientist's approach of making one's knowledge explicit, he will describe what he knows explicitly, i.e. his tools, instead of describing how to use them! … It deserves a special warning because, besides being disastrous, it is so respectable!"

His preferred blending: *"As teachers of programming we should try to blend the technology of the scientist with the pretence of the craftsman."* Sticking to the technology of the scientist means being as explicit as we possibly can about as many aspects of our trade as we can. *"Now the teaching of programming comprises the teaching of facts – facts about systems, machines, programming languages etc. – and it is very easy to be explicit about them, but the trouble is that these facts represent about 10 percent, of what has to be taught: the remaining 90 percent is problem solving and how to avoid unmastered complexity, in short: it is the teaching of thinking, no more and no less."*

Computing Science and Philosophy

"Experimental psychology, neurophysiology, and computer science may turn out to be the best friends of traditional philosophy." Gian-Carlo Rota [10]

Perhaps the best way to explore the Dijkstra-Kay argument is to detour briefly into philosophy. You may think it is impractical and plays no role in computer science, but I would argue that the philosophy of computer science is at the heart of their debate.

We begin with the great Gian-Carlo Rota, whose writings matched the eloquence of Dijkstra. In his essay "The Pernicious Influence of Mathematics upon Philosophy," Rota showed us the parallels between the double life of mathematics and the double life of philosophy. (We will talk about the double life of computer science as well.)

Rota characterized the double life of mathematics as truth and proof. "In the first of its lives mathematics deals with facts, like any other science," he wrote. "The facts of today's mathematics are the springboard for the science of tomorrow." In its second life, Rota wrote, mathematics deals with proofs. "Every fact of mathematics must be ensconced in an axiomatic theory and formally proved if it is to be accepted as true."

In contrast, "In its first of its lives, philosophy sets itself the task of telling us how to look at the world. … Philosophical description make us aware of phenomena that lie at the other end of the spectrum of rationality that science will not and cannot deal with." Then "In its the second life, philosophy, like mathematics, relies of method of argumentation that seems to follow the rules of some logic."

But philosophy "has not been quite as comfortable with its double life," Rota wrote. In its first, philosophy "sets itself the task of telling us how to look at the world … making us aware of phenomena that lie at the other end of the spectrum of rationality that science will not and cannot deal with. The assertions of philosophy are less reliable than assertions of mathematics but they run deeper into the roots of our existence. Philosophical assertions of today will be the common sense of tomorrow."

Axiom 0: Goddess Reason

In its second life, "philosophy, like mathematics, relies on a method of argumentation that seems to follow the rules of some logic," but – unlike mathematics – the rules have "never been clearly agreed upon by philosophers, and much of the philosophical discussion since its Greek beginnings has been spent on method," Rota wrote. "Philosophy's relationship with Goddess Reason is closer to a forced cohabitation than to the romantic liaison which has always existed between Goddess Reason and mathematics."

Are we to believe that Professor Kay would issue a restraining order to keep Goddess Reason from darkening computer science's door?

Axiom 1: Philosophical disclosures are met with anger that we reserve for the betrayal of our family secrets

Rota: "Philosophical arguments are emotion-laden to a greater degree than mathematical arguments and written in a style more reminiscent of a shameful admission than of a dispassionate description. Behind every question of philosophy there lurks a gnarl of unacknowledged emotional cravings which act as a powerful motivation for conclusions in which reason plays at best a supporting role. To bring such hidden emotional cravings out into the open, as philosophers have felt their duty to do, is to ask for trouble. Philosophical disclosures are frequently met with anger that we reserve for the betrayal of our family secrets."

When Jonathan Edwards, a research fellow with the Software Design Group at MIT, was asked to contribute a chapter to Beautiful Code, published in 2007 by O'Reilly, he declined. *"Beauty is an idealistic fantasy," he later explained on the blog Alarming Development [11] "I hope that someday we will discover such principles. But in the meantime software design is still a matter of wisdom, not knowledge, and is therefore largely unteachable."*

He confided: "I am having trouble with this assignment. Telling an inspiring story about a beautiful design feels disingenuous. Yes, we all strive for beautiful code. But that is not what a talented young programmer needs to hear."

Then, as if betraying a family secret, he wrote: "I wish someone had instead warned me that programming is a desperate losing battle against the unconquerable complexity of code, and the treachery of requirements. I can't teach you how to design beautiful code, because I don't know how myself. I may have managed to get a few things almost right. … A lesson I have learned the hard way is that we aren't smart enough. … and above all to prize simplicity. Another lesson I have learned is to distrust beauty. It seems that infatuation

with a design inevitably leads to heartbreak, as overlooked ugly realities intrude. Love is blind, but computers aren't. A long-term relationship – maintaining a system for years – teaches one to appreciate more domestic virtues, such as straightforwardness and conventionality. Beauty is an idealistic fantasy: what really matters is the quality of the never-ending conversation between programmer and code, as each learns from and adapts to the other. Beauty is not a sufficient basis for a happy marriage."

Axiom 2: Dictatorship of Definitiveness

Rota: "Philosophers in this century have suffered more than ever from the dictatorship of definitiveness. The illusion of the final answer, what two thousand years of Western philosophy failed to accomplish."

Axiom 3: Inevitability of Failure

Rota: "A dispassionate look at the history of philosophy discloses two contradictory features: first, these problems [of philosophy] have in no way been solved, nor are they likely to be solved as long as philosophy survives; and second every philosopher who has ever worked on any of these problems has proposed his own 'definite solution,' which has invariantly been rejected by his successors. … Philosophers of the past have repeatedly stressed the essential role of failure in philosophy. The failure of philosophers to reach any kind of agreement does not make their writings any less relevant to the problems of our day. We reread with interest the mutually contradictory theories of mind that Plato, Aristotle, Kant and Comte have bequeathed to us, and find their opinions timely and enlightening, even in problems of artificial intelligence."

Axiom 4: The Myth of Precision

Rota: "The prejudice that a concept must be precisely defined in order to be meaningful, or that an argument must be precisely stated in order to make sense, is one of the most insidious of the twentieth century. … Looked from the vantage point of ordinary experience, the ideal of precision seems preposterous. Our everyday reasoning is not precise, yet it is effective. Nature itself, from the cosmos to the gene, is approximate and inaccurate. … The ideal of precision in philosophy has its roots in a misunderstanding of the notion of rigor."

We misunderstand the concepts of philosophy if we force them to be precise. One insightful metaphor due to Wittgenstein is that philosophical concepts are like the winding streets of an old city, which we must accept as they are, and which we must familiarize ourselves with by strolling through them while admiring their historical heritage. [12]

Axiom 5: Appeal to Psychology

Rota: " … to justify their neglect of most of the old and substantial question of philosophy [they argue] that many questions formerly thought to be philosophical are instead 'purely psychological." … Experimental psychology, neurophysiology, and computer science may turn out to be the best friends of traditional philosophy. The awesome complexities of the phenomena that are being studied in these sciences have convinced scientists (well in advance of philosophical establishment) that progress in science will depend on philosophical research in the most classical vein."

"And if I have to describe the influence PL/1 can have on its users, the closest metaphor that comes to my mind is that of a drug. I remember from a symposium on higher-level programming language a lecture given in defense of PL/1 by a man who described himself as one of its devoted users. But within a one-hour lecture in praise of PL/1 he managed to ask for the addition of about fifty new "features," little supposing that the main source of his problems could very well be that it contained already far too many "features." The speaker displayed all the depressing symptoms of addiction, reduced as he was to the state of mental stagnation in which he could only ask for more, more, more. … When FORTRAN has been called an infantile disorder, full PL/1, with its growth characteristics of a dangerous tumor, could turn out to be a fatal disease." – Dijkstra [13]

Axiom 6: The Illusion of Definitiveness

Rota: "The results of mathematics are definitive. No one will ever improve on a sorting algorithm which has been proved best possible. … Mathematics is forever. … The problems of philosophy are the least likely to have 'solutions.' ... The reality we live in is constituted by a myriad contradictions, which traditional philosophy has taken pains to describe with courageous realism. But contradiction cannot be confronted by minds who have put all their eggs in the basket of precision and definitiveness. The real world is filled with absences, absurdities, abnormalities, aberrances, abominations, abuses, with *Abgrund*."

A Critic's Dilemma

In my previous Conduit article about Dijkstra (part 1) [14], I derived (with a slightly different notation) a "criticism equation": $E=mc^2$ In the equation, the impressionistic quantities are: "*E*" is the "energy" of criticism, "*m*" is the "substance" of the critical message, and "*c*" the "authority" of the critic. Well, Kay's Turing award surely qualifies him for authority, but his *m* is so small that he got no *E* at all. There are two obvious desiderata for a conscious critic that creates a dilemma for her as they are somewhat in conflict. The first axiom, "non-demagogy," says that you should be critical only in areas where you have significant and recognized achievements. The second axiom, "non-personal," says that the critique is more effective when it stays away from the personal biases of the critic. The higher your achievement in an area, the tougher your criticism could be of lesser achievers, so you clearly are biased in your critique towards your kind, failing to satisfy the second axiom. The Spartan criticism of Dijkstra, hard to take by many, is at the root of the "disabling prejudices." He lived a Spartan life, holding himself first at the same high standards that he used to critique others' shortcomings.

"As a scientist Dijkstra was a model of honesty and integrity. Most of his publications were written by him alone. The few publications that he wrote jointly with his colleagues bear the unmistakable trait of his writing style. He never had a secretary and took care of all his correspondence alone. He never sought funds in the form of grants or consulting and never lent his name to the initiatives to which he would not contribute in a substantial way. When colleagues prepared a Festschrift for his sixtieth birthday, published by Springer-Verlag, he took the trouble to thank each of the 61 contributors separately, in a hand-written letter. His supreme self-confidence went

together with a remarkably modest lifestyle, to the point of being spartan. His and his wife's house in Nuenen is simple, small and unassuming. He did not own a TV, a VCR or a mobile telephone, and did not go to the movies. In contrast, he played the piano remarkably well" [15].

As I put the final touches on this article, the recent announcement of Grigory Perelman's solution of the Poincare Conjecture marked another illustration that we must work on what we love. His is a victory of doers over talkers, a victory of the deep theory scientists over craftsmen. We should all celebrate Perelman's achievement and his receipt of the $1 million Clay Mathematical Millennium Prize.

"The question 'What is Mathematics?' is as unavoidable and as unanswerable as the question 'What is Life?' In actual fact I think it's almost the same question." Dijkstra [15]

Dijkstra's Axioms:

Axiom 0: Life = Mathematics

Axiom 1: Computer Science = Mathematics + Murphy's Law

Axiom 2: Beauty is Our Business

Axiom 3: Simplicity is a prerequisite for reliability

FEAR

In 1984, soon after my family fled to the United States, I began telling my friends about life in communist Romania – hard-to-believe stories from a weird world of dictatorship and limited freedom. I told them about the Carpathian president who forced people to attend rallies and chant his name. I described a government composed entirely of the Carpathian's family members; long lines at supermarkets whose shelves were barely stocked; mile-long lines of cars waiting a turn at the gas pump; spending the night in line so that the next morning we could claim our two-bottle ration of milk – available only to parents with young children.

This crazy dictator had a wife who, though only a lab technician in a pharmaceutical research institute, somehow managed to earn her Ph.D. in chemistry in just six months. What an achievement, the newspapers declared. She was immediately promoted to director of the pharmaceutical research institute, where she was listed as co-author – and first author – of the hundreds of papers published annually by the institute. But just in case this did not do justice to her leadership, her name was listed in bold-faced type that was double the size of the other authors.

How can one not promote such a talent to a position aligned well with her stature? It may come as no surprise that the dictator's wife was appointed Minister of Science. Newspapers celebrated the achievement with patriotic pride, and noted that no one had anything critical to say about the appointment, at least on the record.

Our new friends had difficulty believing our stories. Why was no one brave enough to stand up to the regime, they wondered? Such a thing could never happen here in the United States, they said. Could it?

It is hard to talk about fear. I wished for a metaphor, a story to offer my friends as a way to defend my seemingly fearful compatriots. We dealt with the daily problems by telling political jokes – oh, the safe haven of artistic ambiguity! – a folkloric form of prolific and creative protest that occasionally got some of us called up to a certain office where we were told that "on so and so day you told a joke about … we are concerned about you …"

One thing about dictators: Their time for justice comes. That Carpathian dictator and his wife were executed in the revolution. It is said that the members of the execution platoon could not restrain themselves when they marched to execute the couple; some starting shooting before reaching the wall.

They say that patriotism is the last refuge
To which a scoundrel clings
Steal a little an' they throw you in jail
Steal a lot an' they make you king
There's only one step down from here, babe
It's called the land of permanent bliss
What's a sweetheart like you doin'
in a dump like this.

Bob Dylan [16]

"Funding in genomics is measured in nano-Landers!" was a colleague's attempt at survival humor at a recent computational biology conference. The similarity with the nano-Dijkstras quote is only that. These two cannot be more opposite! I am afraid that just about now, the nano could become pico.

Afraid? I guess there are many types of fear. Fear of losing freedom scars you. It wasn't until 2002 that I recognized something similar in the United States. I was working at Celera Genomics, and from time to time we would receive in secret a message from a genomic scientist of stature – an apology for the actions of some of his colleagues. Clearly genomics people were afraid to say positive things in public about Celera for fear of losing their research freedom. I recognized this fear from the experiences in Romania that I was trying to forget. This time, though, I was in the communist republic of genomics.

Father-in-law vs. Pajamas

I sent a silly game of my own to Professor Dijkstra but it has never been published before. I am including it here asking for algorithmic solutions, and offer a prize for their optimal algorithmic solutions, but they have to be "in your head" solutions. The Prize, like the ones I use for my students solving the most difficult parts of the extra credit homework, a slice of Providence's famous, Pastiche Fruit Pie. Write to me at sorin@cs.brown.edu and I will publish winners in the next issue of the Lighthouses.

A Silly Game

A story. A young man lives with his father-in-law, a very active retired man. Among the duties of the father-in-law at home was to wash dirty laundry. It follows that he washes the son-in-law's pajamas too. The son-in-law's N clean pajamas, all different, are stored on a certain shelf S, in a white closet. They are arranged, as usual, in one stack as shown in Fig.1 stack S of pajamas Let B be the basket where the used pajamas are deposited in order to be cleaned. The son-in-law is a very absent-minded young man, and when he changes his pajamas, he acts as follows: throws the used pajamas in B, and puts on the pajamas from the top of S. As already mentioned, the father-in-law is very active, so he puts the laundry in the washing machine as soon as they occur in B. That is, till the washing moment no more than one pajamas has time to appear in B. After washing, the pajamas are returned immediately to the top of S.

After some time (say, years), at a moment when the son-in-law comes to change his pajamas, he discovers a very strange thing: the pajamas he is wearing and the one from the top of S are extremely worn out, while the rest of pajamas are almost new! Then he understood that all the time he has been wearing these two sets of pajamas. The explanation can be obtained as follows: while the son-in-law was wearing pajama 1 the father-in-law quickly washed pajama 2 and placed it on top of S. When he changed the pajamas, he took pajama 2 and put pajama 1 in B which ended up on top of S, and so on. The son-in-law has been wearing the sequence of pajamas 1,2,1,2,1,2 … Our first problem is how to avoid this unfair wearing of pajamas. Let us define a fair wearing of the N pajamas to be a sequence of N pajamas that is any permutation of them.

The Problem. Give an algorithm (if possible the simplest; solvable in your head) for a fair wearing of the pajamas. There is a caveat (inspired by the real-life situation): no communication between son-in-law and father-in-law should be required.

The story, continued. The son-in-law discovered the optimal algorithm for Problem 1. He started using it, so everything seemed to be okay. However, a happy event brought some changes. A son was born. Among the reorganizations involved in the house was the one concerning the clothes. Now, the son-in-law's pajamas were assigned to a small shelf. The pajamas were now arranged in several stacks, say M stacks of maximum height K.

Concerning washing, the father-in-law acts now… non-deterministically. He returns the washed pajamas to the top of any stack he wishes. The nondeterministic return proves troublesome. A new algorithm is needed for the problem. Find the two optimal algorithms for the two versions of the problem.

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The Faculty Speak Out

By **James Hays**

Q&A with James Hays

How did you first become interested in computer science?

While I was growing up, personal computers were rare. However, video game consoles were not. The endless possibilities of these interactive virtual worlds intrigued me from a young age. One of my first significant software development attempts was a random map generator for a Civilization-style game (I still think this is an interesting problem – speculative geology). I've also always been inspired by visions of the future, such as Masamune Shirow's Ghost in the Shell series, in which the lines between humans and computers, and virtual and real worlds become blurred. Computing and its many applications will shape our society dramatically this century. I knew I wanted to be a part of that.

How do you pick your research problems?

I think the massive amount of data on the Internet offers great potential for advancing computer vision and related applications in computer graphics. Some of my research ideas are driven by the data itself – e.g. finding a source or type of data that nobody else has utilized such as photo geotags. I'm also interested in attacking the fundamental problems in image understanding by leveraging Internet data sources. I'm fairly flexible in my research pursuits, though.

> "Computing and its many applications will shape our society dramatically this century. I knew I wanted to be a part of that."

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

Many of the challenges I face are similar to other imaging researchers– finding better features to describe visual content, finding efficient and effective machine learning algorithms. But my research tends to emphasize data more than algorithms. It is challenging to find ways to leverage in-the-wild Internet data that is plentiful but often unstructured and difficult to use.

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

My favorite project is probably "Scene Completion" in which image holes are patched up with data from matching Internet photos. It's a very clear illustration of the power of large data sets – the algorithm is simple, and seems ineffective with small amounts of training data, but it seems very intelligent with millions of training examples.

How do you see your field evolving over the course of your career?

Computer vision is going through the same transition that computer graphics went through in the past two decades – the transition from limited research successes to widespread adoption. Computer graphics is such a success that people can scarcely distinguish real and virtual imagery, and most computers sold today include graphics-specific hardware. On the other hand, many vision researchers think that image understanding is an AI-hard problem that we are decades away from solving. I tend to disagree. There are AI-hard questions you can ask about images, but I think many interesting computer vision problems are solvable in the near future to a degree that will allow other important fields, such as robotics and graphics, to advance significantly.

What's the "next big thing" in computer vision?

That's a difficult question. I'm not sure there is a single "next big thing" in computer vision. I tend to push on research problems related to data and scale, but other researchers are making significant gains by exploring better features, better learning, or better imaging.

Scene understanding will remain a core problem in computer vision, just as photorealistic rendering is a core problem of computer graphics, but as the field matures we are likely to see entirely new research problems emerge. Interactivity and privacy could be more significant concerns.

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

I have very broad interests in history and science and I tend to follow up on them. Wikipedia is an amazing resource, but it only gets you so far. It's hard for me to pick just one area that I would want to study more! That's one of the fantastic things about computing – it's relevant to everybody, so it gives you an avenue to connect with any research area.

Michael Black

Michael Black and his collaborators received new funding from the NIH program for Exceptional, Unconventional Research Enabling Knowledge Acceleration as well as from the NSF program on Collaborative Research in Computational Neuroscience. Michael also received a generous research gift from Intel and his group obtained a full-body 3D laser range scanner on loan from the Army. In an effort to keep the airline industry in business, Michael gave invited talks in Sicily, Prague and Barcelona and attended conferences in Kyoto and Vancouver.

Roger Blumberg

Roger just completed a two-year term as Chairman of the Board of Directors, at the Rhode Island Council for the Humanities (RICH).

During his term, the Council made grant-making its primary focus and this year RICH will make grants to humanities projects and programs in RI totaling approximately $300K. In November, Roger was elected to the Board of the Federation of State Humanities Councils (FSHC) in Washington, which is the membership organization that represents the 56 state and territorial humanities councils supported by the National Endowment for the Humanities. During his tenure at the FSHC, he'll continue to promote the idea that computing should play a greater role in the way the councils think about their work, their constituencies, and the meaning of the humanities in the 21st century.

Rodrigo Fonseca

New faculty member Rodrigo and his wife Paula welcomed their daughter Sofia on December 31, 2009.

Philip Klein

Klein continues to teach The Matrix in Computer Science, a course that teaches linear algebra via CS applications. He has received funding from Google to support work on algorithms related to road maps.

Sorin Istrail

Sorin gave a Keynote Lecture in January at the Asia-Pacific Bioinformatics Conference in Bangalore, at the Tata Institute in India. He then lectured at the Indian Institute of Technology in Chennai. In India, he was most impressed by the structure of the driving traffic which he calls "liquid-traffic," and the population substructure (subpopulations speaking different dialects as well as genomic substructure) with an incredible 3400 such subpopulations. He published, together with his former Brown postdoctoral fellow Fumei Lam, in the Chinese journal "Communication and Information in Systems," the paper "Combinatorial Algorithms for Protein Folding in Lattice Models: A Survey of Mathematical Results" in a special issue of the journal dedicated to the 67th birthday anniversary of Mike Waterman. He also co-authored with his Ph.D. student Ryan Tarpine and Eric Davidson of California Institute of Technology a paper in the Proceedings of the National Academy of Sciences. The computational component of the paper was the result of three years of work on the development of the cisGRN-Browser, a genome browser software system built by Ryan for gene regulatory networks. In the area of genome-wide disease associations, his Ph.D. student Derek Aguiar developed algorithms for the detection of loss of heterogeneity applied to the GWAS data from the Multiple Sclerosis Genetic Consortium. Derek's algorithm detected a signature of missing genomic pieces, characteristic to mental disease; a paper describing the algorithm is to be presented at the RECOMB 2010 Conference in Lisbon. Sorin's two postdoctoral fellows Austin Huang and Alper Uzur have focused their work on HIV and genomic drug resistance, and respectively, the minimum informative subset of genetic variants (SNPs) for preterm labor. Work of Allan Stewart (CS) and Kyle Schutter (Bioengineering) is focused on two honor theses to be finished this Spring: one FCC Protein Folding, and the other on Functional Regulatory Genomics Inference.

Sorin redesigned his graduate course, now called Medical Bioinformatics. Its Fall semester organization included four guest lecturers of distinction: former Director of the National Cancer Institute, Sam Broder of Celera, mathematician John Conway, John von Neumann, Distinguished Professor at Princeton, Associate Director of Genomics of the Food and Drug Aministration, Issam Zineh, and Jonathan Yewdell, renowned immunologist at NIH. For the Course, Alper, also a talented cartoonist contributed with artistic depictions of Course lessons. Sir Ronald Fisher inspired one of them.

Sorin is the Chair of the May 3–7, 2010 Brown University/CCMB Symposium, organized in two parts.

May 3–4, 2010: John von Neumann Distinguished Lecture Series, organized by Leon Cooper (Physics), Stuart Geman (Applied Mathematics), Sorin Istrail (Computer Science), Roberto Serrano (Economics)

Marina von Neumann Whitman (Professor of Business Administration and Public Policy, University of Michigan), Freeman Dyson (Professor Emeritus of Physics, Institute for Advanced Study, Princeton University), John Conway (John von Neumann Professor of Mathematics, Princeton University), Kenneth Arrow (Nobel Laureate, Joan Kenney Professor of Economics and Professor of Operations Research Emeritus, Stanford University), Richard Karp (University Professor, University of California, Berkeley), David Mumford (University Professor, Department of Applied Mathematics, Brown University), Leon Cooper (Nobel Laureate, Thomas J. Watson Professor of Science and Director, Institute for Brain and Neural Systems, Brown University), George Dyson (Historian of science, University of Washington)

May 4–7, 2010: The Genome and the Computational Sciences: The Next Paradigms

Eric H. Davidson (Norman Chandler Professor of Cell Biology, California Institute of Technology), Andrew G. Clark (Jacob Gould Schurmn Professor of Population Genetics, Department of Molecular Biology and Genetics, Cornell University), J. Craig Venter (Founder, Chairman and President, J. Craig Venter Institute (tentative)), Ellen V. Rothenberg (Professor of Biology, California Institute of Technology), Richard Lewontin (Alexander Agassiz Research Professor, Museum of Comparative Zoology, Harvard University), David Botstein (Anthony B. Evnin Professor of Genomics and Director, Lewis-Sigler Institute, Princeton University), Martin Meier-Schellersheim (Team Leader, Computational Biology Group, National Institute of Allergy and Infectious Diseases, NIH), Sean Eddy (Group Leader, Janelia Farm, Howard Hughes Medical Institute), Martha Bulyk (Associate Professor of Medicine and Pathology, Harvard Medical School), Jonathan W. Yewdell (Chief, Biology Section, Laboratory of Viral Diseases, National Institute of Allergy and Infectious Diseases, NIH), David Shaw (Ph.D., Chief Scientist and Founder, D.E. Shaw Research), Marcus Feldman (Professor of Biology, Stanford University)

Barb Meier

Barb continues to teach computer animation production courses. Last summer, she attended a workshop on Storytelling for Educators with two-time Grammy winner and nationally renowned storyteller/singer Bill Harley at the Pendle Hill retreat center outside

Philadelphia. The attendees taught all levels of school from kindergarten through high school, college, grad school, and adult education. The common thread was that, at any level, lessons are more memorable when told as stories. Beyond this, Barb learned ways of helping students create better stories and then applied this to her animation class this past fall. Iterating through several drafts of scripts and storyboards, her students created more complex stories with good endings - the holy grail of storytelling - for their animations. As long as they are going to pull several all-nighters to make their animations, they may as well be telling good stories! Bill Harley is based in the Providence area, but performs nationwide in family and adult concerts and at storytelling festivals. Check him out if he's in your area. You'll go home entertained and wiser!

Meinolf Sellmann

Meinolf's 2009 started with a sabbatical leave which he used to visit colleagues all over Europe and the States. Among others, Meinolf gave talks at the Max Planck Institute for Informatics in Saarbruecken, Ecole Polytechnique Federale de Lausanne, Oxford University, University of St. Andrews, the Cork Constraint Computation Centre, University of Waterloo, Georigia Tech, and the Sandia National Laboratories in Albuquerque.

Meinolf published a paper at Constraints, two papers at CPAIOR, four at CP, and two at ICTAI. The latter two both received best paper nominations, whereby one was co-authored by Meinolf's graduate student Yuri Malitsky. In collaboration with Chris Jefferson from Oxford University, Meinolf was invited to give a tutorial on "Amortized and Expected Case Complexity for Filtering Algorithms" at CP in Lisbon.

Meinolf is excited that his research has been incorporated in various combinatorial solvers last year. IBM has integrated Meinolf's and graduate student Serdar Kadioglu's work on biased binary search in their optimization software. The Jacob CP solver developed at EPFL now contains the efficient knapsack filtering algorithm that Meinolf co-developed in 2007. Lufthansa Systems Berlin invited Meinolf to talk about grammar constraints which Meinolf invented in 2006 and which they want to integrate into their crew scheduling system. Grammar constraints are also being used by his colleagues in Montreal to solve real-world nurse shift scheduling problems efficiently.

John Savage shown with 8 of the 10 Jefferson Science Fellows in front of the White House

Finally, Meinolf secured an international collaboration grant supplement from NSF and is looking forward to visiting his colleagues in Sweden this summer.

Andy van Dam

In early December Andy van Dam attended the retirement of his good friend and fellow graphics old-timer Jose Encarnacao, from the Technical University Darmstadt (Germany) where Andy got an honorary degree in 1995. He gave two talks on multi-touch computing in honor of Jose, one at the TU and the other at the nearby Fraunhofer Institute for Research in Computer Graphics, the world's largest graphics research lab which Jose had created in the '90s and headed until a few years ago, and which had a branch for nearly ten years in Providence. Andy chaired the Technical Advisory Board of the Providence branch during that time.

On that same trip, he, his undergraduate research assistant Donnie Kendall, Brown's head Librarian Harriette Hemmassi, and Prof. Massimo Riva, an expert in Italian Studies, met with colleagues at the British Library to discuss deployment of the "Garibaldi on the Surface" project in a public exhibition on digital research that the British Library will mount in the Fall of 2010. The project was started under Microsoft Research sponsorship at Brown to allow interactive browsing of the Garibaldi Panorama on the Microsoft Surface, a coffee-table sized display that allows multiple users to interact via multi-touch and pen. The panorama is a 273 foot by four and half foot long scroll of individual painted scenes, depicting the life and times of the great Italian hero that Brown had previously digitized but couldn't really display properly. This work will be the featured application on the Surface during the approximately six months the exhibition will run, and this spring the team is working on fleshing out both the functionality and user interface of the browsing application and the hypermedia content of the Garibaldi web. The project parallels work done on "tangible math", manipulating mathematical equations on the Surface, again using multi-touch and pen. Also good progress has been made on a Google-sponsored research project to probe the utility of gestures for command on the Android platform. There currently are a group of students including undergraduates Ferdi Adeputra, Gal Peleg, Ali Ozler, Donnie Kendall, masters student Hsu-Sheng Ko, a Ph.D. student (Andrew Bragdon, leading the Google project) and a full-time researcher (Director of Research, Bob Zeleznik) working on these projects.

Recent Ph.D.s

Alex Balan

Eric Rachlin

Will Headden

Yossi Lev

Department Awards and Honors

Brown University/National University of Singapore Computational Biology Degree Program

Brown University and the National University of Singapore (NUS) have established a concurrent computational biology degree program. Students who complete the program will receive concurrent degrees from NUS and Brown: a bachelor's degree in computational biology from NUS and a master's degree in computer science with a special designation in computational biology from Brown. Franco Preparata, who has been a visiting faculty at NUS for several years, is the primary architect of this program at Brown. Tom Doeppner has also been involved in setting up the program.

Brown President Ruth J. Simmons said, "The sequencing of the human genome has opened a vast new area of research at the junction of the computing and biomedical sciences. Computational biology is growing at Brown. We are excited by the possibilities of this new relationship with the National University of Singapore."

Ben Raphael Receives Sloan Research Fellowship

Ben Raphael was recently awarded the prestigious Sloan Research Fellowship, one of the oldest and most competitive fellowship programs in the United States.

Ben's remarkable work developing novel computational and mathematical approaches to problems in biology, especially cancer genomics and comparative genomics, led to his inclusion in this elite group.

Selection procedures for the Sloan Research Fellowships are designed to identify those who show the most outstanding promise for fundamental contributions to new knowledge. "I am deeply honored to be selected as a Sloan fellow," said Ben. "During my career, I have been fortunate to work in environments that promoted my research and to collaborate with exceptional scientists from various disciplines. I am pleased that the Sloan Fellowship provides the opportunity to continue my ongoing work and to push my research in new directions."

The fellowships are awarded by the Alfred P. Sloan Foundation to honor and promote the science of outstanding researchers early in their academic careers. The 118 winners are faculty members at 55 colleges and universities in the United States and Canada who are conducting research at the frontiers of physics, chemistry, computational and evolutionary molecular biology, computer science, economics, mathematics and neuroscience. They receive grants of $50,000 for a two-year period to pursue whatever lines of inquiry are of most interest to them. The funds are planned to be used to support the work of Ben and his students in computational cancer genomics.

Aside from the monetary aspect of the fellowships, less tangible benefits have been cited by former Sloan fellows. The early recognition of distinguished performance which the fellowships confer, after years of arduous preparation, was said to be immensely encouraging and a stimulus to personal and career development.

The Sloan Research Fellowships have been awarded since 1955. Past recipients have gone on to win 38 Nobel prizes, 14 Fields Medals (mathematics), and eight John Bates Clark awards (economics).

Besides his Sloan Fellowship, Ben has previously received other recognition for his work, including a Career Award at the Scientific Interface from the Burroughs Wellcome Fund, an outstanding accomplishment.

Ph.D. program in Computational Molecular Biology

The Center for Computational Molecular Biology and the Department of Computer Science are delighted to announce the new Ph.D. program in Computational Molecular Biology. Applications for admission into this program are being accepted now. Current courses supporting the degree are in Computer Science, Applied Mathematics, Mathematics, Biological Sciences, and Chemistry.

The Center for Computational Molecular Biology (CCMB) at Brown is a world-class center for research and scholarship in this new discipline. CCMB's central mission is to make breakthrough discoveries in the life sciences at the molecular and cellular level through the

Professor Franco Preparata

Ben Raphael

creative application of existing data-analytic methods, and to develop the novel computational, mathematical, and statistical technologies required to exploit the opportunities emerging from advances in genomics and proteomics.

The Center concentrates its efforts on a small number of fundamental biological themes: algorithmic methods and statistical inference in genomics, comparative genomics and evolution, gene regulatory networks, regulatory genomics, mathematical models of genetic variation, and cancer genomics. They focus on building truly interdisciplinary research teams with other multi- and transdisciplinary centers at Brown. Since sophisticated computational, mathematical and statistical technologies are imperative for the success of the center's goals, technologies have been developed in areas of fundamental biological themes with the aim of generating testable predictions, capitalizing on expertise in these methodologies in the departments of Applied Mathematics and Computer Science.

Faculty members currently associated with CCMB are Alexander Brodsky, Assistant Professor of Medical Science; William Fairbrother, Assistant Professor of Biology; Sorin Istrail, Director; Julie Nguyen Brown Professor of Computer Science; Charles Lawrence, Director 2004-2006; Professor of Applied Mathematics; Franco Preparata, An Wang Professor of Computer Science; David Rand, Professor of Biology; Sohini Ramachandran, Assistant Professor of Ecology and Evolutionary Biology (to join Brown in July 2010); Benjamin Raphael, Assistant Professor of Computer Science; William Suggs, Associate Professor of Chemistry and Biochemistry; Daniel Weinreich, Assistant Professor of Biology; and Zhijin (Jean) Wu, Assistant Professor of Medical Science.

Tom Dean Named ACM Fellow

The Association for Computing Machinery (ACM) recently elevated Tom Dean to Fellow for his development of dynamic Bayes networks and anytime algorithms.

Tom is currently a staff research scientist at Google, Mountain View, and an Adjunct Professor of Computer Science here at Brown. He is known in AI for his work on the role of prediction in planning, control and decision-making where uncertainty and the limited time available for deliberation complicate the problem, particularly his work on temporal graphical models and their application in solving robotics and decision-support problems. His temporal Bayesian networks, later called dynamic Bayes networks, made it possible to factor very large state spaces and their corresponding transition probabilities into compact representations, using the tools and theory of graphical models. He was the first to apply factored Markov decision processes to robotics and, in particular, to the problem of simultaneous localization and map building (SLAM). Faced with the need to solve what were essentially intractable problems in real-time, Dean coined the name "anytime algorithm" to describe a class of approximate inference algorithms and the associated (meta) decision problem of deliberation scheduling to address the challenges of bounded-time decision making. These methods have been applied to large-scale problems at NASA, Honeywell and elsewhere.

At Google, Tom has worked on extracting stable spatiotemporal features from video and developed new, improved features for video understanding, categorization and ranking. From 1993 to 2007 he was Professor of Computer Science and Cognitive and Linguistic Sciences at Brown. He remains associated with the University through his Adjunct Professorship.

Tom received his B.A. in mathematics from Virginia Polytechnic Institute & State University in 1982 and his M.Sc. and Ph.D. in computer science from Yale University in 1984 and 1986 respectively. His research interests include automated planning and control, computational biology, machine learning, neural modeling, probabilistic inference, robotics and spatial and temporal reasoning.

Tom was named a fellow of AAAI in 1994. He served as the Deputy Provost of Brown University from 2003 to 2005, as the chair of Brown's Computer Science Department from 1997 until 2002, and as the Acting Vice President for Computing and Information Services from 2001 until 2002. Tom was a founding member of the Academic Alliance of the National Center for Women and Information Technology and a former member of the IJCAI Inc. Board of Trustees. He has served on the Executive Council of AAAI and the Computing Research Association Board of Directors. Tom was also a recipient of an NSF Presidential Young Investigator Award in 1989. Dean is co-author with Mike Wellman of the Morgan-Kaufmann text entitled Planning and Control which ties together techniques from artificial intelligence, operations research, control theory, and the decision sciences. He is co-author with James Allen and John Aloimonos of Artificial Intelligence: Theory and Practice, an introductory text in Artificial Intelligence. His latest book, *Talking With Computers* is published by Cambridge University Press and examines a wide range of topics from digital logic and machine language to artificial intelligence and searching the web.

Commenting on what he is currently working on and excited about, Tom said, "More than a year ago I became concerned that the features that Google was using to catalog video were not good at capturing the fundamental characteristics of biological motion. When you look at the most popular videos on YouTube, they invariably involve biological motion, from sports and music videos to nature documentaries and misbehaving-pet videos. The effort of taking this initial observation and translating it into a set of algorithms for first learning motion features and then extracting them from video in better than real time has been both satisfying and humbling. The experience has also convinced me that a significant fraction of the image, video and audio data processing that we perform is better suited to a different model of computing than what we currently support in the cloud, hence my recent work on exploiting many-core computing in a way that is agnostic regarding both hardware and programming language. For most of the time I was at Brown, I was the only person working in robotics and decision making — regrettably, for much of the time that I overlapped with Chad, Michael and Leslie Kaelbling, I was up to my neck in administration. Now that I'm on the other side of the country, the department has hired two of the very best researchers working in the areas of computer vision that I'm most excited about. I'm referring to Erik's work on hierarchical graphical models and James' work on exploiting very large image corpora. I really appreciate the department providing me with even more incentives to visit."

The ACM Fellows Program was established by Council in 1993 to recognize and honor outstanding ACM members for their achievements in computer science and information technology and for their significant contributions to the mission of the ACM. The ACM Fellows serve as distinguished colleagues to whom the ACM and its members look for guidance and leadership as the world of information technology evolves.

Tom joins the department's seven other ACM Fellows: Maurice Herlihy, Franco Preparata, John Savage, Eli Upfal, Andy van Dam, Peter Wegner and Stan Zdonik.

Tom Dean

Flapjax Recognized with Best Student Paper Award at OOPSLA

A group of Brown students have worked for three years on Flapjax, a new programming language built atop JavaScript. Their work was recognized with the Best Student Paper award at The International Conference on Object Oriented Programming, Systems, Languages and Applications (OOPSLA 2009) in Orlando, Florida. The Flapjax group includes four undergrads–Leo Meyerovich '07 (currently a third-year Ph.D. student at Berkeley), Jacob Baskin '08 (now at Google), Michael Greenberg '07 (now a third-year Ph.D. student at University of Pennsylvania), and Aleks Bromfield '08, Master's '09 (now at Microsoft) –and two Ph.D. students, Greg Cooper '08 (now at Google) and Arjun Guha, all working with Shriram Krishnamurthi.

Parenthetically Speaking

By **Shriram Krishnamurthi**

People suffering from chemical dependency are sometimes fortunate to avail themselves of treatment in rehabilitation centers. Unfortunately, a one- to three-month period of in-clinic *treatment* is only a precursor to, and in no way guarantees, the real goal, which is *recovery* (the part that, in the case of celebrities, doesn't make it onto nightly TV). Therefore, rehabilitation programs need to monitor, evaluate, and encourage their patients on the road to recovery. And one key to successful recovery is communication.

In spring 2009, our senior software engineering course (CSCI 1900) worked on the problem of automating communication with recovering patients. We worked with a series of centers currently operating in Brazil (or Brasil, as they spell it in Portuguese). Our contact there is John Burns, an American who has been serving in various capacities (Peace Corps, etc.) in Brazil for several decades. John is now based in São Paulo.

About 25 years ago, John created Vila Serena, a network of chemical dependency treatment centers around the country. Vila Serena has treated tens of thousands of patients during this time. Some of these centers kindly agreed to test our system with a group of recovering dependents.

The primary task for the system was to track patients through the recovery process after in-patient care, which is known as *continuing care, aftercare*, or (in Portuguese) *pós-tratamento*. Before they are checked out, patients are made to create a recovery plan. These are often designed in conjunction with the family members, and signed in their presence, to aid recovery. A key part of the plan is to stay in constant (if brief) communication with the clinics.

Unfortunately, communication is not an easy problem. How do patients communicate with the clinic? The Internet isn't always easily available, especially in the developing world (even people who have good connectivity at work might not at home). Phoning in is much easier, since virtually every patient owns a mobile phone, but calls are very resource-intensive for the clinic: handling hundreds of calls requires significant investment in personnel; simply routing the calls to an answering machine is not only impersonal, it still requires someone to listen to the messages (in case someone has called in to report a personal crisis). For this reason, though well aware of the value in such communication, John's clinics (and others) have failed to implement it.

But these ubiquitous mobile phones have one other means of communication: SMS. This medium offers many advantages relative to phone calls. Messages can be processed asynchronously without the negative connotation of an answering machine. Messages are delivered as text, so they can be eyeballed quickly. Messages are short, further reducing the time demand. And contemporary phone users are comfortable writing short notes with SMS.

Our students worked with John and his staff to collect requirements for the system. We had enough students to split the class into two groups. Each group was given the same task—to build a system for Vila Serena—but was told to not communicate with the other, i.e., to behave like the other group was a corporate competitor. One reason for this was to see whether the groups would obtain significantly different requirements or even, for the same requirements, implement very different solutions.

The two groups' requirements were similar, but not identical. In part, this was because of features—such as inter-patient communication—proposed by some of the group members, which were enthusiastically adopted by the Vila Serena staff.

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 provide resources and employment opportunities to our students and to allow our faculty to engage in meaningful research collaborations.

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But even with fairly similar requirements, the two groups proposed significantly different solutions.

A minor point of difference was the choice of implementation technology (Java versus Ruby on Rails), dictated largely by what some of the students were most comfortable with or most interested in learning. A much more important difference was in how the teams chose to interface between SMS and computer. One group chose to buy a SIM card for their server machine, effectively receiving and processing messages locally. The other group investigated and chose Internet-based SMS gateways, which handle the SIM details and offer an API for obtaining the messages. These two solutions have numerous trade-offs (which should be evident to the reader), and at different points in the semester, different solutions appeared to have the upper hand. In the end, however, I believe both groups felt the gateway-based solution was better.

These differences demonstrate that having the two teams work on the problem independently was not merely a cosmetic detail. Their divergence helped the class understand two very different technologies in some detail, thereby better informing them when they encounter a similar problem in the future.

The system built by the students collected the SMS messages and collated them against the patients' identities. It compared the frequency of response against what was set out in their "contracts" at discharge, notifying clinic staff when a patient was off schedule. It offered an intentionally simple, usable "inbox" interface that clinic staff would use to check messages. The systems could also send messages to patients, such as a periodic question or "message of the day". Most of all, staff could flag messages that suggested a need for more personal follow-up. (It is important to note that at no point did the student-built software make any *clinical* decisions. Instead, it merely mimicked and automated what would have been done by a horde of humans, per their specification.)

The good news is that both groups successfully completed their systems, and both were deployed in Brazil. Along the way, I believe the groups learned a good deal about working with real clients, managing privacy, dealing with non-technical users, interfacing between the Internet and SMS, using the phone (rather than a computer terminal) as the primary communication device, supporting internationalization, designing user interfaces, and adapting to foreign cultures. Twice, for instance, communication from Brazil seemed to halt entirely, to the students' surprise. Any guesses why? (Read on.)

There is growing interest in the use of SMS in medicine; for instance, a BBC article

http://news.bbc.co.uk/2/hi/uk_news/magazine/7858425.stm

describes the use of SMS communication to help people suffering from seasonal affective disorder. The system built in this class falls in a similar vein. Indeed, this system appears to have commercial potential, and some students have been in conversation with healthcare organizations about adaptations of it.

Credits

Adam Emrich and Hamzah Ansari, both of who were graduate students in Brown's PRIME (Innovation Management and Entrepreneurship Engineering) program, conceived of this project and identified the Brazilian clinic. The staff at Vila Serena was generous with both time and knowledge. John Burns, in particular, was profoundly generous with his time and ideas, putting extraordinary effort into the project. In numerous ways, it would have been impossible without him.

Oh yeah, the two interruptions. One was Easter; the other, Carnival!

Around the Department

Pascal Van Hentenryck Cha Chas in Dancing with the Profs

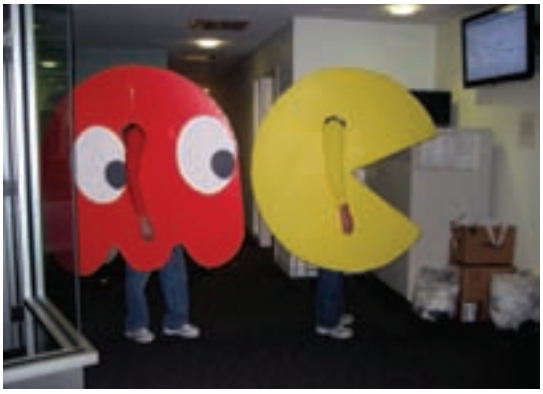
Pascal was one of six professors who took to the stage in a packed Alumnae Hall for "Dancing with the Profs" on February 12, 2010.

The event, now in its third year, was created by the Brown Ballroom Dance Team, who practiced with the six professors for three months, and then competed with a 90-second routine, each choosing a different dance.

Pascal, in a fedora and white socks, and Lan Shiow Tsai '10 danced the cha-cha to Michael Jackson's "Billie Jean." Judge Julie Strandberg praised the pair's "creativity and wonderful sense of humor." Although Pascal and Lan didn't win, the dance-off was still a CS victory with Daniel Hackney '12 stealing the show with his spirited jive with partner, Assistant Professor of Sociology Nancy Luke.

Halloween

The department celebrated Halloween with the annual party, including a costume contest and pumpkin carving.



College Hill Programming Competition

The College Hill Programming Competition was held on March 6, 2010. The competition for high school students hosted by the Brown CS DUG and featured a talk given by Andy van Dam. Prizes were generously donated by Industrial Partners Adobe, Facebook, Google, Microsoft and NetApp.

Note from the CS DUG:

Hey graduates – doing something interesting with CS? Whether you're at a startup, doing research or anything else, the CS DUG would love to hear from you. If you'd like to give undergraduates an idea of what they can do with a Brown CS degree, let us know by emailing dug@cs.brown.edu.

Bootstrap at Brown

Students enrolled in project Bootstrap, a curriculum for middle-school students that teaches them programming through images and animations, gather in the CIT several times per week and are taught by Brown CS students. Bootstrap uses algebra as the vehicle for creating this imaginative content, resulting in much greater student engagement in subsequent math classes. Historically, Bootstrap attendees have been predominantly minority and economically disadvantaged, with about a quarter female. Shriram Krishnamurthi is responsible for the Bootstrap effort at Brown. The Bootstrap team also includes Matthias Felleisen at Northeastern, Kathi Fisler at WPI, and Emmanuel Schanzer at Harvard. Funding for the program has been provided by Google.

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