Computer Science
UNIVERSITY OF TORONTO

@dcs 2012

INTRODUCING
THE UNIVERSITY OF
TORONTO'S NEW

Centre for Collaborative Interactive Digital Media

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INSIDE:

Message From the Chair

Over the past year, the Department of Computer Science has continued to gain momentum. We continue to place in the top 10 international rankings in the area of computer science, in both the Fall 2011 Shanghai Academic Ranking of World Universities and QS World University Rankings. We have also had another banner year of faculty awards, including Geoff Hinton's Killam Prize, Renee Miller's appointment as a Fellow of the Royal Society of Canada, Paul Gries' Ontario Confederation of University Faculty Association Teaching Award, and Karen Reid's U of T President's Teaching Award. We continue to strengthen our reputation for excellence in research and teaching, not to mention scholarship – our students are also receiving the field's top awards.

We are pleased to celebrate our burgeoning Professional Masters (MScAC) program, and we have experienced a recent surge in undergraduate enrollments. The MScAC, which graduated its inaugural class this June, has been growing by leaps and bounds. The first year was a huge success, resulting in all 6 students being offered permanent jobs by their internship companies, and we will welcome 20 new students to the program this fall. Within this issue of *@dcs,* you'll see an interview with a current MScAC student, Uzma Khan – I think you'll agree that this specialized program, with its focus on exploratory industry research, provides a unique, enriching experience for some pretty extraordinary students. As I mentioned above, the undergraduate program enrollment has increased by 28% over the last year, an exhilarating development that we welcome – and a challenge as we work to accommodate this growth amidst budget constraints.

To that end (and to address the many other needs typical of a world-class department), we are exploring some new ways of supporting the department and its research and teaching. One noteworthy initiative is the department joining the University of Toronto's groundbreaking Boundless fundraising campaign. The campaign, with a goal of $2 billion, will enable us to clarify our top priorities and continue the revolutionary, collaborative research that the department is known for.

Finally, at the departmental retreat this past spring, as we reviewed our activities, successes and future plans, we found ourselves focusing on one constant priority: building our sense of community. At the Department of Computer Science, our greatest strength is undoubtedly our people – faculty, staff, and students, who devote their time and efforts to creating the best environment for innovative research and teaching. I assure you that our alumni and friends of the department are a crucial piece of this community as well, acting as mentors and taking the time to work with our faculty and students – sharing expertise, and gaining insight into the very latest in Computer Science. We all benefit from these relationships, and I have had the pleasure of seeing firsthand how powerful these interactions can be.

"Undergraduate program enrollment has increased by 28% over the last year."

In the coming year, it is our hope that we can ramp up our activities with alumni and friends, and I reiterate our appeal for you to get in touch to discuss ways in which you can get involved with the department. If you're interested in engaging in any aspect of departmental life, whether keeping up-to-date or making contributions to our many activities in teaching, scholarship, or public outreach, don't hesitate to contact us!

The 2012 *@dcs* is full of stories about the exciting work being done by our faculty, students, and alumni. I hope this issue of *@dcs* inspires you.

Sven Dickinson
CHAIR, DCS

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Profile: Zoya Gavrilov, Recent Graduate

Q: What CS degree did you complete this June?
A: Specialist in Computer Science and Statistics

Q: What experience have you gained over these past 4 years?
A: I have worked on very interesting research projects in computer vision. Last summer I worked with professors from Boston University on American Sign Language recognition, leading up to a publication and a workshop in Turkey. Additionally, under the guidance of Professor Sven Dickinson, I have had ample experience putting together presentations, navigating research papers, designing research posters, and writing up my work. My choice to go to graduate school is thus very much a conscious one, in that I know what to expect.

Q: What kinds of extracurricular activities have you been involved in at UofT?
A: During my second year, I was on the executive team of the Computer Science Student Union, organizing and promoting events. During my third year, I founded the Undergraduate Artificial Intelligence Group. We met on a weekly basis, reading and discussing papers in A.I., as well as inviting graduate students to give talks on their research.

Q: During your time at DCS, what have been your most memorable moments?
A: The most rewarding moments were organizing two successful events at DCS. One was a first-year CSSU orientation event: with tours of the department, a lunch, and an information session. The second was an Artificial Intelligence day - a half-day event complete with talks by faculty and graduate students.

Q: Do you have any advice for current CS undergraduates?
A: Not enough undergraduates are seeking out research opportunities. Perhaps they feel they do not know enough to contribute to research. On the contrary, at any level of knowledge, one can almost certainly contribute something, and as you acquire further knowledge, you can develop your ideas more thoroughly. Moreover, you'll be learning precisely the things that will help you advance your research and allow you to discover what you are passionate about.

Q: What did you do to seek out research opportunities?
A: In first year, I started asking my professors about research opportunities. It's all about making connections: Paul Gries introduced me to Greg Wilson who introduced me to Sven Dickinson. Sven Dickinson has been my supervisor ever since, and I have been very lucky. He gave me the freedom to choose and work on what I wanted as well as to develop my own perspectives and ideas; at the same time, he always made sure I was on the right track. I am greatly indebted to Professor Dickinson for helping make my academic experience such a positive one.

Q: What can undergraduates do to get more involved?
A: Ask questions! The Undergraduate Office is a great resource at DCS – for course choices, research, and work opportunities. Also, visit your professors during office hours – seek their advice on topics related to academia, industry, and computer science in general. Yet another resource is graduate students – ask them about their research, their academic choices, and their regrets! Finally, don't ignore any opportunities that get sent out in the departmental newsletter, that get posted on the computer science bulletin boards, and that get announced in class. Take advantage of all of these resources, so you don't have to justify your inaction to yourself later. ■

Profile: Noel D'Souza, Second-Year Student

Q: What CS stream are you majoring or specializing in?
A: After an excellent experience at DCS, I've changed my focus from Cognitive Science to Computer Science. (I plan to continue exploring human cognition and integrate it into my CS studies.) I have not decided on a concentration yet, but Scientific Computing, Computer Vision and Human-Computer Interaction all seem very interesting.

Q: What is it about computer science that appeals to you the most?
A: CS' combination of abstract ideas and tangible tools greatly appeals to me. I enjoy problem solving, and I'm looking forward to working on more and more interesting problems.

Q: What has been your favorite course at DCS?
A: Introduction to CS (CSC 148) was a great mix of new concepts, interesting projects and fun people (students, professors and teaching assistants), led by wonderful professor Paul Gries. It was actually my favorite course at the University last year.

Q: What do you find challenging about CS?
A: I struggle with properly conceptualizing my work. I regularly find myself starting to implement a solution before I've adequately thought through my problem; I end up feeling lost in a maze. However, I'm getting better about my work process.

Q: Of everything that you have accomplished so far, what are you most proud of?
A: I am most proud of a series of eight assignments I completed for the Mathematical Expression and Reasoning course (CSC 165). I drew upon skills and knowledge from a wide range of courses to complete the assignments. When I look at them today, I see a picture of my growth during the past two semesters.

Q: Are you currently involved in any extracurricular activities at UofT?
A: Last semester I started Mindfulness Meditation and t'ai chi at the Multifaith Centre (both taught by cognitive science professor

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Profile: Uzma Khan, MScAC Student

Uzma Khan, currently a student in the department's flourishing Master of Science in Applied Computing (MScAC) program, took a quick detour on her way to graduate school – first starting on the career and family path. "Now that both of my girls are full-time in school, I thought this may be the perfect time to go back to school and complete my education," Khan explains. "I had previously been working as a software consultant in the United States, and after I had moved to Canada and had done a project with the Ontario Cancer Institute… I realized I wanted to go back to school and get a fresh academic perspective on CS."

Khan looked into various programs, but was focused on finding a degree that would not only expand her knowledge base about current cutting-edge CS research, but would also provide her with skills she could apply in a practical setting upon her return to industry. The Department of Computer Science's professional masters, with its balance of 8 months of coursework, followed by 8 months of an industrial internship, fit the bill.

"The MScAC seemed to be that perfect choice… When I read the details, I felt the program was literally 'tailor-made' for me," Khan enthuses. When asked about what areas of CS appeal to her the most, she notes, "I enjoy designing and developing user interfaces for various user groups… I am now exploring building gesture and touch-based interfaces for Microsoft Kinect applications and mobile devices." Khan was also able to explore that passion during her MScAC coursework: "For example, in my course project for CSC2524-fall (user experiences with next-generation input-output technologies), I employed Microsoft Kinect for Windows to explore the use of gestures and speech in the area of education for younger children," says Khan. "That work was well-received by parents and educators alike and has been featured on Microsoft's blog and gallery for the Kinect."

Khan started the internship portion of the MScAC in May, and is working with a team at EHealth Innovation in the University Hospital Network. Using the knowledge and skills she has gained related to user-centered design, she is developing an asthma self-management mobile web application. Khan shares: "More than anything, I am excited and feel very happy about working on a one-of-a-kind application that can make a difference in the lives of asthma patients."

Uzma Khan and her daughter, Sanaz, as they demonstrate Khan's project on "Using Gestures and Speech for K-2 Education" at the department's annual Research in Action showcase in March.

Soon enough, Khan will have to start figuring out her next steps. "[The MScAC] program has opened up many doors for me… with my increased knowledge in bioinformatics, I might return to working for cancer research, or I may continue to expand on my internship training in developing mobile web applications for health." She continues, "The excellent training received in leadership, communication, and technical entrepreneurship during this program may also allow me to translate some of my course projects into viable business opportunities… or I might just return back to the industry working on various exciting software applications." This myriad of options might be daunting, but Khan assures us, "For the moment, I'm just living in the present, enjoying the program to the fullest and maximizing the learning opportunities being presented to me."

When asked about the one lesson she will take away from the MScAC, Khan considers the question. "Learning never stops," she observes. "It's never too late to go to school and gain new knowledge. This program helped me realize my hidden potential. I broadened my knowledge in CS, and connected with great minds – including my fellow classmates and the wonderful faculty." She goes on: "We wonder why there are few women in CS compared to men… this would be my message to all moms out there, working or homemakers, who did their undergrad a long time ago: professional masters programs like the MScAC are a great way to come back to academics, discover your potential, and gain a fresh new perspective - and can jumpstart a career in CS." She repeats, simply: "it's never too late." ■

"Professional masters programs like the MScAC are a great way to come back to academics, discover your potential, and gain a fresh new perspective..."

Profile: Utkarsh Roy, MSc Student

There are some common traits that characterize DCS graduate students: they are ambitious, overachieving and talented individuals who are striving to make an impact in as many areas as possible. Utkarsh Roy is no exception. As a graduate student at the department, a UofT ambassador and a young author, he is building a reputation for excellence.

Roy is a student in the Computer Systems and Networking lab, supervised by Professor Eyal de Lara. He is currently working in the area of Cloud Computing and Virtualization: "My current project deals with scale down of cloud infrastructure," Roy shares. "Cloud is a rapidly growing area of interest in the computing world. Many organizations are starting to adapt this technology, which essentially means processing and storing data on remote servers, so that when applications receive a spike in load, they can scale up quickly, easily and inexpensively by provisioning infrastructure dynamically on what we call 'the cloud'." Roy maintains that, "While many computer scientists and organizations are looking at aspects of scaling up, my research revolves around challenges of scaling down, a solution which will inevitably be necessary in the future, when infrastructure would have scaled up too much!"

As Roy works to solve future problems in computing, he also takes the time to consider looming world issues, acting as an ambassador for DCS and UofT on the international stage, at the fourth-annual Festival of Thinkers Conference this past November. The conference, held in Abu Dhabi, focuses on generating innovative ideas from a diverse group of world leaders from various disciplines. For example, the conference attendees discussed issues such as environmental sustainability, economic downturn, climate change, the future energy crisis and global health. The conference invited scientists, academics, industry leaders as well as Nobel Laureates to engage and interact with students, young scholars and researchers from universities around the world. Roy, the sole UofT representative, was among the 100 students from 40 countries who were chosen to attend this unique conference.

While these endeavours are impressive enough on their own, Roy also indulges in another passion with success: writing. He was motivated to write his first novel entitled *Let's Get Committed,* which was published in early 2011. The novel centers on young people and their experiences of friendship, love and college life. "The book has struck a chord with the youth and I feel happy to get positive feedback from the readers," Roy says. "I have started writing my second book, which I plan on finishing by the end of this year."

The multi-talented Mr. Roy doesn't appear to be slowing down anytime soon! ■

Roy represented the University of Toronto at the annual Festival of Thinkers in Abu Dhabi.

Going Places

This past year's class of graduates (MSc, MScAC, PhD) have moved on to places including:

- Ontario Institute for Cancer Research
- Nuance Communications
- Microsoft Research Asia
- Pixar Animation Studios
- 2 startups (currently unnamed)
- Altera
- Thoora Inc.
- Ontario Ministry of Education
- Wilfred Laurier University
- SecureKey Technologies Inc.
- California Institute of Technology
- Side Effects Software
- University of Toronto
- MDA Space Missions
- IBM
- Google
- Intrafinity Inc.
- Technologies for Aging Gracefully Lab (TAGlab)
- an independent consulting company

A renovation spanning approximately 1100 square meters of space has breathed new life into the Bahen Centre for Information Technology.

The Department of Computer Science Celebrates Centre for Collaborative

After almost two years of construction, students and faculty have begun to enjoy the new Centre for Collaborative Interactive Digital Media (CCIDM), which spans parts of the fourth and fifth floors of the Bahen Centre for Information Technology on UofT's St. George campus. The CCIDM boasts not only student research space, but essential labs and areas that foster cooperation between research groups. The centre houses faculty, students and research from a myriad of areas: systems, networks, mobile computing, databases, computer vision, computer graphics, and human-computer interaction. The renovation also includes research and lab space for visitors from other research areas and organizations; this area is currently being utilized by the extra-departmental Knowledge Media Design Institute (KMDI).

Faculty member Gerald Penn and grad student Siavesh Kazemian pose in the acoustic lab with boxes of old CBC video footage; they are currently working on digitizing years of old news reports.

Enhancing Collaboration

One of the main goals of the CCIDM project was to create an exciting space that brings together faculty and students from different research groups in computer science and beyond. In response to the prevalence of digital media in the world today, it was critical that the department take a huge step forward, creating a cross-collaborative environment that not only provided physical space for study and research, but reinforced the concept of shared space, making the connections between the various research areas seamless.

Professor Eugene Fiume, who played a major role in the development of the CCIDM project from its CFI proposal to its actual construction, notes, "What is really important to us is that people understand that this new space is open to everyone – we have created this centre to encourage more interdisciplinary work at the department and beyond."

Fostering Innovation

The lab spaces are also ready for a range of research exploration – the rooms are reconfigurable, providing a new level of flexibility. "The idea is that students can use the space for research more quickly and easily," professor Daniel Wigdor, whose area is Human-Computer Interaction, explains. "The way we have set things up, a student can have a great idea at 10 a.m.; by noon might have built a physical prototype; by 3 p.m., the prototype is a touch-sensing device, and by 5 that afternoon, the student has already tested it with potential users and knows what to do with it the next day."

The CCIDM also boasts a large amount of open, daylit space with writing surfaces: whiteboards, chalkboards, even window glass and tables – every hallway anticipates the birth of the next Big Research Idea. Wigdor's postdoctoral student, Ricardo Jota, notes appreciatively, "Even the most impromptu, random idea is but a second away from a surface that can be used to record it… the space provides

(Left) Faculty member Ryan Johnson and grad student Ben Reilly discuss data structures.

(Right) Systems & Networks grad students Milad Eftekhar and Amirali Salehi-Abari sketch out some ideas on a table in the CCIDM's central interactive space.

the Establishment of UofT's new Interactive Digital Media

Postdoctoral fellow Ricardo Jota and undergrad Michael Andrae work on a bicycle they have fitted out with sensors. Various parts of the bike react to swipe, pressure, and touch commands; for example, if the user gets a phone call while out riding, they can touch the bicycle bell and automatically send a text message to the caller saying, "I am riding my bicycle. I will get back to you as soon as I can."

HIGHLIGHTS

BY THE END OF THE YEAR, THE NEW FACILITIES IN THE CCIDM WILL INCLUDE:

- A usability lab, for human-computer interaction experimentation
- A 3D display research lab for new display technologies
- A large active display room for large-format displays
- An image acquisition lab to extract properties of objects from images
- A media production lab, which includes motion-capture equipment
- A noise isolation acoustic lab
- Several new systems and mobility labs
- An observation room for conducting research studies
- A common information hub for the informal exchange of ideas and spontaneous conversations
- A seminar room for presentations and interactive video conferencing
- A large number of smaller graduate research labs in aid of collaborative research

for much more free-flowing conversations." He sums it up: "It really helps my creativity."

Creating Endless Possibilities

While the space is still getting final touches, faculty and students already detect a change in the atmosphere. "We were literally breaking down barriers [with this renovation]," Wigdor observes. "Having all the students in one space is already making a difference… and we are really excited about having more opportunities for cross-pollination with the systems group."

Gerald Penn, professor in Computational Linguistics and the department's Associate Chair of Research & Industrial Relations, concurs: "I'm particularly excited by the possibility of collaborating with the networking people on mobile computing technology. " He continues, "The ever-shrinking size of mobile devices is shouting (no pun intended) for a speech interface, but speech and natural language processing have historically been relegated to artificial intelligence. Now that applications in AI have reached a point of maturity where they can realistically be deployed, it makes a lot of sense for them to be placed within the context of digital media."

Faculty and students have already begun settling into the CCIDM, and one can only imagine what innovations will be born here in the years to come. Jota observes, "The space is very welcoming… overall, I'd say students feel more at home in this kind of environment." He adds, "A number of visitors have commented on how awesome the space feels and that I must love working here – and I do." ■

Scientific Research's Right-Hand Man:

Numerical Analysis work allows science to "push further"

Responding to the spread of infectious diseases. Improving medical imaging quality. Predicting weather patterns. Designing satellite orbits. Modelling waves in the St. Lawrence Seaway. These are just some examples of the areas that are benefitting from the computational work the Numerical Analysis group is doing at DCS.

Faculty members Christina Christara, Wayne Enright, and Ken Jackson sat down with *@dcs* to discuss their research, shedding light on both the more general problems they are working on and their real applications. The group works with mathematical models (primarily involving differential equations), which have major implications for various situations and phenomena, such as those arising in the areas mentioned above. Enright explains, "Our work helps people do things like design vaccination strategies for dealing with the spread of disease. The tools we provide allow scientists to respond to a problem, like maximizing the benefit of a vaccination strategy which may be constrained by limited funds." Jackson says, "We see ourselves as support for other areas of science – physics, chemistry, biology."

"We aren't necessarily developing the models," Enright adds. "We're interested in working with existing models, and focusing on simulating and approximating their solutions." The group strives to "push further"; Christara observes: "We come in when an area – for example, finance – wants to do something more complicated, mathematically. If they want to extend an existing program – improve its accuracy, make it more efficient, or introduce more features – we can come up with solutions that allow this." When asked to elaborate on the work related to medical imaging, Christara describes a particular project being done with CT scans: "we are providing information that will allow researchers to find ways to use the least amount of radiation and still get the highest quality image."

In addition to this important, applied research, the NA faculty also have the opportunity to do more abstract, "big picture" work. Christara notes, "We might spend time improving techniques for the approximate solution of a generic differential equation, not necessarily

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Wayne Enright, Christina Christara and Ken Jackson

RESEARCH HIGHLIGHTS:

Parameter estimation for differential equations

Enright and his students are developing effective software tools for parameter-determination and sensitivity analysis of mathematical models that can be described by systems of differential equations.

For example, a critical problem in this area is the use of a mathematical model of an emerging epidemic to design effective vaccination and treatment strategies. Realistic models of an epidemic depend on several key parameters (e.g. infection rates, incubation period, infection period, immunization period) which must be identified from limited and often "noisy" clinical data, before these strategies can be ananlysed and developed. Using accurate and reliable simulation tools, combined with effective search strategies from the machine learning community, they have been able to solve problems involving 5-10 parameters. This is an improvement over traditional techniques, but more realistic problems can involve more than 20 parameters and they are currently considering how to best solve such problems.

High-performance PDE methods for pricing complex financial derivatives

The fair and accurate pricing of financial derivative products is ubiquitous in today's world, when so many complex products are traded and the economies around the globe are so inter-dependent. One type of financial derivative products are Power Reverse Dual Currency (PRDC) swaps.

In a related project, Christina Christara and her collaborators study the pricing of PRDC swaps, using as main mathematical model the Black-Scholes Partial Differential Equation, in three or more spatial dimensions. The dimensionality of the problem by itself poses a computational challenge. When one considers various exotic features of the PRDC swap, the complexity of the solution procedure increases even further.

How accurate is a numerical method for computing the solution to such a problem? To what extent can we use a number of computers or processors working in parallel to reduce the calculation time? How to take advantage of the latest processors, e.g. Graphics Processing Units, to solve such complex problems on relatively cheap computers? Christara's research aims at answering such questions.

Medical imaging

Ken Jackson is working on several projects applying numerical methods to solve problems in finance, biomechanics, biochemical kinetics and medical imaging. One such problem is finding a way to cope with "beam-hardening" artifacts in Computerized Tomography (CT). These artifacts arise because most CT image reconstruction algorithms assume that the X-rays used for the CT scan all have the same energy. This makes the mathematics of the problem much simpler. However, in reality, X-rays are poly-energetic. This mismatch between the assumptions of the algorithm and the true physics of the problem reduces the image quality.

Jackson, Dhavide Aruliah (University of Ontario Institute of Technology) and PhD student Nargol Rezvani developed a CT reconstruction algorithm that takes into account the poly-energetic nature of the X-rays. This algorithm shows considerable promise in improving the quality of images that suffer from beam-hardening artifacts. They are now considering ways to make the computation more efficient and to extend the technique to a wider range of CT scanning geometries. ■

Cross-Country: Undergraduate course provides students with the unique opportunity to do projects with students and mentors from across Canada

Professors everywhere share the challenge of emulating real world projects within the limitations of a course. With UCOSP, the Undergraduate Open-source Capstone Project, DCS students work in teams on existing open-source projects. Although students earn course credit in CSC494/495, there are no phony deadlines or artificial incentives. The students have real features to implement for real users and they have to work within the existing code base and deadlines of a real project. But what makes UCOSP really stand out is that each team is made up of students from universities across Canada. Each team has a mentor from their open-source organization, and early in the semester, teams are flown in to one city for a weekend-long, face-to-face code sprint that launches them into the code.

Fall 2011's code sprint was held at the University of British Columbia, Vancouver.

For the student participants, the UCOSP experience boosts the "soft" skills that employers seek, particularly communication skills. When your team members aren't down the hallway and most of your meetings take place online, the importance of communicating clearly in meetings and taking good notes becomes obvious. This brings real benefit to the project as well. Much more of what might normally happen in conversation ends up being written down, leaving an archive of how decisions were made and what the issues were. "For MarkUs, these artifacts are of great value. And they are not artificially created – they're needed for the project, not for marks," says Karen Reid, mentor for the MarkUs project, and Associate Chair for Undergraduate Studies.

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An Interdisciplinary Approach: CSC200Y brings together different disciplines to discuss social and economic networks

Professors Allan Borodin and Craig Boutilier teamed up to design an interdisciplinary undergraduate course, *Social and Economic Networks: Models and Applications* (CSC200Y). Introduced in fall 2011, and being offered again this coming fall, CSC200Y focuses on teaching students the mathematical and computational tools needed to analyze social and economic networks in modern society. Course topics include the structural analysis of social networks, matching markets, trading networks, web search, auctions and online advertising, information cascades, prediction markets, and voting systems, to name a few. Students are provided with background on graph theory, social network formation, and game theory.

The need for such a course arose from the increasing interest in the social sciences in the computer science perspective on modeling and analyzing social and economic interactions. The computational study of economic and social networks has become a popular topic in CS research areas such as algorithms, machine learning, and databases. By exploiting massive amounts of data, these are transforming our understanding of online interactions. Along with the burgeoning impact of this area, several factors inspired the creation of the course. Apart from Borodin's and Boutilier's interest in the areas of computational game theory and social choice, this type of course was initially taught at Cornell University by David Easley and Jon Kleinberg, with great success. "We think this is the kind of course that almost anyone can profit from," say Professors Borodin and Boutilier. "We believe that it is important for CS to establish better ties with the social sciences."

What is so valuable about CSC200Y is its interdisciplinary approach to learning; students from almost any academic discipline (in addition to CS), can take this course. In particular, it would be beneficial for students in areas such as sociology, economics, commerce and psychology. As Professors Borodin and Boutilier see it, computer science students are able to can gain a better appreciation for issues in social science and economics, while social science students gain some perspective on how networking and other mathematical models shed more light on social and economic concepts. This intertwining of disciplines makes the course experience for faculty and students even richer; it can have a constructive impact on students' perceptions of our contemporary environment. ■

"Students from almost any academic discipline... can take this course."

G. Scott Graham: Retiring after 42 years at the University of Toronto

Q: What do you like the most about the field of Computer Science?
A: The newness and the freshness of the ideas. I started in Operating Systems and at the time, there was still a lot of spark and vitality in researching the core, fundamental ideas. More recently, I have been doing computer (or digital) forensics and in that area, the freshness comes from applying techniques from several different areas.

Q: What has made DCS special for you?
A: The people. The staff. The students. Most of the faculty (ha ha).

Q: Who has had the most impact on you and your research?
A: My PhD adviser, Peter J. Denning. He talked about whether you wanted to walk the path well-travelled or you wanted to take a machete and hack your way through the jungle, unclear about the final destination. He talked about risk and reward. He was also a stickler about writing and communication.

Q: What was your favourite course to teach?
A: A tie. I was the long-time instructor of CSC 468 (as it was numbered), Operating Systems, cross-listed as 2204. I taught that course for years, to Arts and Science undergraduates, Engineering Science undergraduates, and DCS graduate students. More recently, I have been teaching Computer Forensics under various numbers (469 and 2208 on St. George and 233 and 423 at UTM).

Q: What accomplishment to date are you the most proud about?
A: Well, besides my family, I think it was my long-time role as the Discipline Representative (sort of an Associate Chair) for Computer Science at Erindale College (now UTM). Most of the work was done behind the scenes, without a lot of hoopla. I was the first DR, with three CSC faculty. There were faculty hires, faculty resignations, faculty moving to St. George, tensions between campuses. Not a lot of headline material, but the work had to be done to stay afloat, to get us where we are today.

Q: What are your hobbies?
A: Photography. Complaining.

Q: What are your plans after UofT?
A: The UofT, to me, was DCS, with the graduate and research components, and UTM, with undergraduate and administrative components. I hope to still do some part-time teaching. What I can't seem to shake is my role as a Dean's Designate for Academic Offences at UTM, which I've held since 2003 – a long time in that role. The Dean's Office at UTM has told me that they will not let me "retire" – I have to stay on as a DD.

Q: What is the fondest memory you have of DCS?
A: Playing softball in the summers, on front campus. We had good departmental teams and were usually competing against Medieval Studies for the championship. And of course, getting together afterwards. Playing hockey as well.

As a graduate student, organizing one of the first Christmas parties in the department and giving Tom Hull, our chair, a toy duck as a present, because he was always saying that numerical analysts were regarded as queer ducks. Not that there is anything wrong with that. Being a numerical analyst, that is.

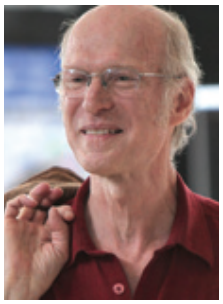
Q: What will you miss most about leaving DCS?
A: The people. And the Bahen building. Love it or hate it, I was the Computer Science liaison person with the architects at the design stage and for what seemed like years, I went to bed with that building and I woke up to that building. ■

Stepping Down in June 2012

(Left to right) Rick Hehner delivers his "Out with a Howl" retirement lecture; Chair Sven Dickinson congratulates Scott Graham on his retirement; Graham and Hehner share a few words at the annual Stepping Down celebration.

Rick Hehner: Retiring after 43 years at the University of Toronto

Q: What do you like most about the field of computer science?
A: When I came to UofT in 1969 as a graduate student of physics, I discovered a group of people just upstairs (on the eleventh and twelfth floors of the physics building), who were just bubbling with enthusiasm for their work. That's where computer science was just starting up, as a field and a department. Back then, it was not clear whether there was enough material for a respectable academic discipline; it was likened to "telephone science" (and phones were really primitive then). I have watched, and participated in, the progress of CS from then until now; it has been amazing and wonderful. I have seen the entire field develop from almost nothing to the most active, productive, and varied subject in the university. What better field could there be?



Q: Who has had the most mpact on you and your research?
A: I guess that's Sir C.A.R. Hoare and Edsger W. Dijkstra. They largely created the field of formal methods; Edsger was a good friend and mentor, and Tony still is. In 1977, I was lucky to be made a member and secretary of the International Federation for Information Processing (IFIP) working group 2.3. It's a group of about 25 researchers in my field from all over the world, including 5 Turing award winners. In 1998 I was made a member of working group 2.1, which developed Algol 60 and Algol 68 and influenced Haskell. Each group meets for a week every 9 months, and we discuss each other's research. That's been the biggest influence on my research.

Q: What research project have you enjoyed working on most?
A: The project originally called "predicative programming". My idea was to treat programs as executable specifications, and treat specifications as boolean expressions (predicates). The 1999 book *Funding a Revolution: Government Support for Computing Research, by the National Research Council* (U.S.A.), said, "In this approach, programs are derived from specifications by algebraic calculation. In the most advanced manifestation, formulated by Eric Hehner, programming is identified with mathematical logic. Although it remains to be seen whether this degree of mathematization will eventually become common practice, the history of engineering analysis suggests that this outcome is likely." In the meantime, it resulted in several PhD theses, several books (including one by me), changed the course of Tony Hoare's research, and became a conference series.

Q: What was your favourite course to teach?
A: CSC465/2104 Formal Methods of Software Design. I created the course in 1982, and wrote two textbooks for it (the Logic of Programming, 1984; a Practical Theory of Programming, 1993, 2002, 2012). I won't claim the course was popular; few people chose it. But each year, there were several students who became enthusiastic about the material, and that was rewarding. I also really enjoyed teaching CSC258 Computer Organization, which I have taught since 1974. Keeping that course up-to-date has been fun, and I even snuck in a little of my own research on high-level circuit design.

Q: What accomplishment to date are you most proud of?
A: I am proudest of my students who wrote brilliant theses and went on to do great work in academia or industry. Several became heads of computer science departments, and one became the Microsoft vice-president in charge of software development.

Q: What has made DCS special for you?
A: I could have been a big fish in a little pond, but I much prefer to be a little fish in a big pond. I have been surrounded by the brightest and best faculty, staff, and students. But it's more than that. A couple of times I was the target of recruiting by other universities, including Stanford and the Oregon Graduate Institute, but UofT DCS, has always had a supportive culture, and that's why I have stayed here. We treat each other with respect, and we cooperate. I have spent time at many other places, and they aren't always as nice to each other as we are.

DCS Awards Highlights

Killam Prize in Engineering 2012
Geoff Hinton (Faculty)

ACM SIGMOD Jim Gray Doctoral Dissertation Award 2012
Ryan Johnson (Faculty)

NSERC Synergy Award 2011
Eugene Fiume (Faculty) and Autodesk

University of Toronto President's Teaching Award 2011-2012
Karen Reid (Faculty)

Ontario Confederation of University Faculty Association Teaching Award 2011
Paul Gries (Faculty)

Arbor Award, University of Toronto Alumni Association, 2011
Celeste Francis Esteves (Staff)

Bill Buxton Best Canadian HCI Dissertation Award 2011
David Dearman (Graduate student)

For more awards, see the departmental webpage: www.cs.toronto.edu/dcs/awards.

Q: What are your hobbies?
A: My main hobby is folk music. I play guitar and violin and piano (not at the same time), and I am part of two groups that play regularly. The songs I lead seem mostly to involve death; I don't know why. I ski, and I snorkel (not at the same time). I still like to travel, although I can't do short stay trips across many time zones any more.

Q: What are your plans after DCS?
A: It's a cliché, but I want to spend more time with my wife than was possible when we were both working; she has just retired, too. We're going to try to avoid winter as much as possible. I hope I'll have more time for music, and I want to do some writing that isn't CS research.

Q: What is the fondest memory you have of DCS?
A: Well, how about this one: I was just finishing my PhD, thinking about applying for a job, and making a list of places I might like to apply to. The chair of DCS at the time, Tom Hull, said, "Forget about it – you'll work for us." I didn't even ask what the salary would be; I just said ok. So I've never applied for a job in my life. That was a different world!

Q: What will you miss most about leaving DCS?
A: Leaving? Wait a minute – I'm retiring, who said anything about leaving? ■

Profile: Paul Gries, Senior Lecturer

Q: What do you love about Computer Science?
A: I love the puzzles, I love helping students discover beautiful code, and I love how computer science is used in so many other domains. We're influenced by and collaborate with psychology, stats, math, engineering, biology, linguistics, and many more disciplines. I always have something new to learn and to look forward to.

Q: Why did you decide to go into teaching?
A: My Dad is my biggest inspiration. He teaches Computer Science at Cornell University, where I got my degree. He was my professor in the second CS course, and I got to see firsthand why he won so many teaching awards. I later was an undergrad TA, and found myself spending way too much time on that, ignoring my studies. Helping people understand concepts gives me a rush that I haven't found in anything else.

Later on, when I was doing my Masters at Cornell, I had Sam Toueg as a professor. He was full of passion and fire and fun, and so clearly enjoyed teaching and helping people learn. He is the one who made me consider doing a PhD, and it's his fault that I applied to the University of Toronto.

Once I got here, I took the grad course on Graph Theory from Derek Corneil. Like Sam, he breathed joy and excitement for the course material and for teaching. It was in that course that I finally decided that I wanted to teach for a living rather than explore non-academic options: I felt I could bring the same positive energy and love for the discipline that shone in Dad, Sam, and Derek. When the UofT added the teaching stream in the late 90's, I knew that was a perfect job for me.

Q: What about teaching at DCS, in particular, appeals to you?
A: I love the incredibly positive message that we lecturers have had from the 4 recent chairs. All of them – Eugene, Craig, Fahiem, and Sven – have encouraged us to build a community and have always given us strong support. The DCS lecturer community is fantastic: we drop into each others' offices for advice, we work closely together to make sure the courses we're teaching are coherent, and a group of us has coffee almost every day. They're my friends as much as they are my coworkers.

Q: What has changed about your teaching style over the years?
A: I'm less forgiving for students who don't do the work. I suppose that means that I'm more blunt with students: I'm more willing to point out how much time (both theirs and mine) students have wasted, and I'm less patient when someone resists trying out a suggestion I have.

Q: What teaching innovations currently excite you?
A: I'm planning on doing the inverted classroom next year, where students will watch screencasts of course material, and then in lecture we will do problem solving, small group work, and more. I haven't tried this before, and I'm looking forward to learning a ton about the best ways to do it right.

Q: Is there anything (beyond the CS technical details) you hope you impart to your students?
A: I'd love it if all my students learned to think before they type. That's the biggest frustration I have: far too many people have a guess-and-check mentality, and that hurts their understanding, inhibits their learning, and wastes their time. We give tons of tips on how to approach finding a solution, and it seems like almost a majority either don't believe us or don't quite understand the tips. Hopefully the inverted classroom will let me spend more time on this kind of thing.

Q: What do you enjoy doing in your spare time? (What might people not know about you?)
A: I love to sing, but don't get to do it enough. Every now and then I think about getting a small group together to do some fun a capella, but I haven't managed to get around to it yet. I also write bad poetry and sometimes filk songs (rewriting their lyrics for humorous effect). I recently took part in the Arts & Science Exam Jam and nobody came for the first three hours (!), so I filked "Alone at a Drive-In Movie" (from *Grease*) and posted it on the course discussion boards: "I'm so alooooooone/ At the Exam Jam/ It makes me feel like such a sham/ Tree recursing without you…" Sadly, nobody asked me to sing it. ■

STAFF Q&A

Leanne Dawkins | UNDERGRADUATE PROGRAM ADMINISTRATOR

Q: What is your favourite part about your job?
A: Meeting and talking to students, both current and prospective is, hands-down, the best part of working in the Undergraduate Office. I also really love being involved in the First-Year Learning Communities (FLCs).
Q: What do you enjoy doing in your spare time?
A: I am a hardcore DIYer. I recently completed a kitchen reno that I did myself start to finish, from demo and design to the installation of cupboards. I also enjoy sitting with my son and my dog on the dock of my cottage, drinking margaritas and reading the latest CanLit hit.

Celeste Francis Esteves | GRADUATE PROGRAM ADMINISTRATOR

Q: What is your favourite part about your job?
A: I can't think of a better place to be - Toronto is Canada's ICT and entrepreneurial hub and here I am supporting the faculty and students that make it so!
Q: What do you enjoy doing in your spare time?
A: Spending time with friends and family; especially my 5 year old – she helps me keep things in perspective. ■

Scientific Research's Right-Hand Man

(continued from page 8)

for a specific application." This more theoretical aspect of the field can benefit several practical applications in the end: "Even when we are just modeling one specific phenomenon," Enright adds, "The equations can often be used in many different areas." The "background" analysis can require months and even years of work, while most practitioners are simply interested in the final results that relate to their own research.

"It's fun discovering new possibilities and algorithms. As computers get faster and more sophisticated, we can take our work further and do things that we couldn't computationally do before."

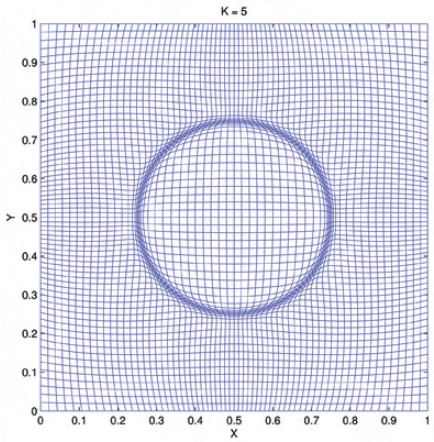
– Wayne Enright

Like all true academics, the faculty members are excited about their work. Jackson says, "We're always discovering something new," and Enright adds, "It's fun discovering new possibilities and algorithms. As computers get faster and more sophisticated, we can take our work further and do things that we couldn't computationally do before. And we need to keep testing and evaluating the quality of the results, because people trust computers and their mathematical results more now than ever before – which is not always justified." Christara is also excited about the widespread impact of NA work: "There are lots of applications for these methods [that we are working on]… and there is something attractive in the math, and something very satisfying about achieving better results."

NA draws an interesting group of graduate students – while they should be strong mathematically, and fluent in programming, Christara also mentions that it helps if they have outside interests in related areas. "It's a good sign if they are aware of what is going on in areas like biology, medicine – the areas that need our work [and can use our applications]."

Outside of careers in academia, most of the recent NA graduates have taken positions in areas like computational finance. More and more are starting to work with research groups in hospitals, and one graduate has gone to Environment Canada, doing work on visualizing weather maps. Jackson emphasizes that there are a growing number of opportunities for NA graduates in the hospitals: "Researchers needs folks with strong math backgrounds." When asked about what types of projects NA people are doing in hospital jobs, he describes some work a current PhD student is doing: "He is working on a research team that is focused on the treatment of scoliosis [the abnormal curving of the spine]. He is helping to develop computer models to determine the most effective size and placement of screws in the patient's spinal column, to alleviate the spinal curvature."

Recent PhD graduate Nargol Rezvani reflects on her experience in the group: "In the NA group, I've had the opportunity to meet smart computer scientists and mathematicians from all over the world and work with them on interesting problems – which has consequently allowed me to gain a good estimation of who I really am and where I stand as a researcher." Rezvani was able to work on a couple of major



Adaptive grid generated dynamically during the partial differential equation (PDE) solution process.

research projects related to x-ray imaging, the second being in collaboration with Princess Margaret Hospital, located a couple of blocks away from campus. *(See Ken Jackson's research highlight in the box on page 8.)* Current PhD student Mohammad Shakourifar reflects on his own experience with the diverse range of research the NA group undertakes: "My own research is in a general area of scientific computation which focuses on the development of reliable numerical methods and software related to integro-differential equations often arising in population dynamics. At the same time, I am engaged in a research project on interactive treatment planning in cancer radiotherapy."

With so many exciting areas needing solutions from the NA group, there appears to be an overwhelming number of possible projects and discoveries. Christara describes the group's work with a typically modest demeanor: "We're trying to find solutions to the mathematical problems of the world." ■

Profile: Alena Gondor, BSc 1983, MSc 1985, Senior Technical Analyst at New Horizon System Solutions

Alena Gondor was destined for a career in IT. Although her high school did not offer computer science courses, Gondor excelled in math. In her last year of high school, she visited UofT, where "I sat in on a first year computer science lecture given by Professor Derek Corneil," Gondor explains. "Needless to say, that lecture made a great impression on me!" After graduating a semester early from high school, Gondor worked at Ontario Hydro in the Data Management department. "It was there that I learned to program (in COBOL), thanks to a wonderful supervisor who mentored me through the basics of programming [and brought my skills] up to a working level."

At that point, Gondor knew she had to brush up on her skills further, and so decided to pursue computer science at DCS. In her fourth year, she took a numerical analysis course that required students to work on a major project. She was encouraged to contact Professor Tom Hull about working with him on some of his research, and it was a tremendous experience. "At the time, Prof. Hull had developed an extension to the Turing programming language called 'Numerical Turing', which had two major features: one being "clean" arithmetic, i.e. decimal (no translation from hex) and the second being dynamically variable precision." The fourth-year project with Prof. Hull went so well that Gondor did an additional project course with him, worked as his research assistant, and eventually went on to do a Master's degree with Prof. Hull as her thesis advisor. "He was a very warm person who really cared about his students and provided lots of guidance to help us all succeed," Gondor recalls. "He helped make my experience at DCS a very memorable one."

After graduate school, Gondor established a very successful career; she currently works at an outsourcing firm that provides IT services in the energy sector. "Specifically, I am part of a team that supports our client's intranet, internet and extranet as well as various web applications," she explains. "I have a lot of interaction with our clients and users to provide support, resolve problems and design enhancements. I enjoy working with clients to understand their requirements or problems and then figuring out the solutions - it is like

Profile: Nilesh Bansal, MSc 2007, Chief Technology Officer at Sysomos

A hallway discussion back in 2005 about possible MSc thesis topics led Nilesh Bansal into a business venture he never anticipated.

Coming from India, Bansal's choice for graduate school was his first serendipitous step: "Initially, I was focused on American schools," he shares. "However, during my undergraduate program, I did an internship at the University of British Columbia, which introduced me to Canadian schools." Bansal ended up choosing "DCS for its very strong faculty and great research atmosphere – and I am glad I made the right choice."

Bansal continues: "DCS provides an overall good environment for both the research and non-research parts of graduate life. One of the highlights of UofT and DCS is that it is supportive of the commercialization of research work." Working with his supervisor, Professor Nick Koudas, Bansal was able to take his academic work to the next level. The now-legendary hallway conversation about thesis topics spun Bansal's work in data mining and the use of contextual analytics into what eventually became Sysomos, a business intelligence solutions company for social media monitoring.

"One of the highlights of... DCS is that it is supportive of the commercialization of research."

"Once people knew what type of work we were doing in the lab, we had many people knocking our door to inquire about a commercial version of the software," Bansal explains. "These requests lead to the creation of Sysomos, so we could commercialize the soft-

solving puzzles every day."

As an annual volunteer for the department's alumni-student mentorship program, Gondor takes the time to provide guidance to current DCS students. "Things have changed greatly since I was at the department," she observes. "Employers are putting a higher value on soft skills than ever before." Any tips? "Besides good technical knowledge, companies require people skilled in writing, planning, team work, etc… Students may not be aware that they already use these skills as university students – but they need to actively try to improve them."

It appears that Gondor was fortunate to have some encouraging individuals cross her path – and now we are fortunate that she continues to play her own "supporting role" in the lives of today's DCS students. ■

ware platform. After raising venture capital in December 2008, we added business functions to aggressively sell the product." In 2010, Sysomos was acquired by Marketwire, a social communications company with offices in Canada, the United States and Europe. The company has been a great success, and now provides their services to the largest global brands, including Coca Cola, Microsoft, and Intel.

For Bansal, his experience from academia into the business world has been an incredible learning process: "The whole journey was unplanned, but enjoyable. DCS was very supportive throughout the process." In fact, while Bansal maintains his role at Sysomos, he has returned to the department to finish his PhD, where he is again part of the Database Systems group, supervised by none other than his "colleague" Nick Koudas. Even with his studies, Bansal is making time for himself: "I have more free time now that Sysomos is a mature business… I can spend more time on things I enjoy doing in my personal life, like Latin dancing!"

As someone who has experienced real success over the past few years, Bansal advises, "This will sound like a cliché, but do what you enjoy, and do it only for that reason." Cliché or not, this has clearly worked for him. ■

Noel D'Souza

(continued from page 3)

John Vervaeke). I also enjoy rock climbing, so I hope to join the University of Toronto Rock Climbing Club next semester.

Q: What has been your most memorable DCS moment so far?

A: Last semester I worked on a treemap assignment with Mark Mereshensky, a fellow undergrad. We were building a GUI application (a first for me) that would display disk usage. I remember one night in the Bahen building in particular: as we were finishing the main tiling algorithm, we launched the application several times – and it kept crashing. When it finally came together, we had an incomplete but working application, and I had an overwhelming feeling of happiness tinged with possibility at this virtual representation of those lines of code.

Q: Are there any professors that have influenced or inspired you?

A: Professor Diane Horton has been both influential and inspirational. She is a great teacher – intelligent, knowledgeable, patient, and sincerely interested in creating a better learning environment for students. I was lucky enough to have taken the Introduction to Computer Programming (CSC 108) course with her, and it dramatically changed my view of CS, and ultimately my path at UofT.

Q: What advice do you have for students looking to take CS at UofT?

A: Reach out to the faculty. The professors at DCS are extremely supportive and really want to help students get the most of the program. Also, get used to paper and pencil. Their simplicity and versatility make them a great tool for planning and reasoning. ■

Cross-Country

(continued from page 9)

UCOSP students have contributed to a wide range of projects such as MediaWiki, the wiki software used by Wikipedia, POSIT, a tool that allows rescue workers to transmit data from their mobile phones, and MarkUs, a tool for assignment submission, grading and code review.

Started by adjunct professor Greg Wilson in 2008, UCOSP has grown to include 18 universities. Over 250 students have completed UCOSP since 2008. With Stanford University's Department of Computer Science asking to participate next year, it appears the influence of UCOSP is poised to spread beyond Canada in the very near future.

The impact on students has been terrific. DCS graduate Mike Conley recalls how UCOSP prepared him for his work at the Mozilla Corporation. "UCOSP really drove home the notion of what it is to produce software that people use every day. I eventually transitioned to the role of mentor – and it's awesome to be able to pay forward and reinvest in a course that gave me so much."

"What makes UCOSP really stand out is that each [project] team is made up of students from universities across Canada."

Reid's role as a mentor has been highly rewarding. "It is a joy to help these students evolve from junior programmers to authorities who the new students seek out for help. It's also really fun to watch them getting to know students from other universities. They see how they stack up, and everyone ends up feeling proud of their home institution."

Michelle Craig, a senior lecturer and chair of the UCOSP Steering Committee, is impressed with the students' commitment to their projects. "It's amazing to see them chiming in on the project mailing list or contributing to code reviews months or even years later." She is also pleased that UCOSP is accessible to all students. "Thanks to sponsorship from Google, Facebook, and others, flight and hotel expenses for the code sprint weekend are covered, which makes that face-to-face meeting possible." ■

RESEARCH IN ACTION March 2012

CONVOCATION June 2012

IN FOCUS

1 Industry guests discuss grad student Volodymyr Mnih's project, "Machine Learning for Aerial Image Interpretation."

2 Dustin Freeman demonstrates his "Improv Remix" project.

3 The 6th annual Research in Action Showcase was held at the Royal Conservatory of Music.

4 A group shot of our inaugural MScAC grads as they cross King's College field.

5 UofT President David Naylor joins staff members Sara Burns *(left)* and Orbelina Cortez *(right)* to celebrate the newest class of computer science graduates.

6 Undergraduate Botond Ballo *(center)* received the 2012 Governor General's Silver Medal for achieving the highest academic standing upon graduation. On his graduation day, Ballo is flanked *(left to right)* by Vice Chair Sheila McIlraith, Senior Lecturer Jennifer Campbell and Associate Chair, Undergraduate Programs, Karen Reid.

7 Undergraduate Awards (Nov. 2011): Award winners Emily Denton *(left)* and Zoya Gavrilov *(right)* exchange words at the UG Awards Reception.

8 Mentorship Launch (Jan. 2012): Arturo Martinez Peguero *(mentee, left)* and Rouzbeh Farahmand (mentor, right) get acquainted as a DCS mentorship match.

9 Level Up (April 2012): The Level Up gaming event held at the Courthouse featured video games created by CSC404 students.

10 UofT Federal Grant Recipients Reception (May 2012): The DCS contingent celebrated its NSERC award winners at the Faculty Club: *(left to right)* Celeste Francis Esteves (Graduate Program Administrator), Utkarsh Roy, Michael Dzamba, Ray Suprio, Ye Yuli (Award Winners) and Prof. Sven Dickinson (Chair).

11 Open House (April 2012): Saman Alvi speaks to high school students about a mobile app she worked on for the Canadian Automobile Association (CAA), as part of her Professional Experience Year internship.