Stretching the boundaries

Derek Reilly and his students explore new ways of interacting with computers in the real world

Scientific honours
An alumnus story

Faculty of Computer Science
cs.dal.ca
Digital technology pervades our everyday lives. We can find nearby Thai restaurants, compare reviews, menus and prices, and view relative distances and locations on interactive maps or superimposed onto our field of view. We can follow a route to a chosen spot and be reminded that we need to buy a birthday card as we pass the local stationary store. At the restaurant, we can capture and immediately share images and videos, annotated with time, place and the people present. Before leaving, we can even add our own review.

The situation at home is no less dizzying. We are building complex networks of entertainment and communication devices—even security systems, energy systems and appliances, not to mention laptops, tablets and an increasing array of peripherals—all of which we expect to work together seamlessly. Even in sport, GPS-enabled watches and heart rate monitors allow athletes to track, visualize and analyze their performance across multiple dimensions.

These scenarios, and many of the technologies underlying them, were first explored in an area of computer science called ubiquitous computing (ubicomp). The mission of ubicomp is to support people in their everyday lives. Ubicomp is the interdisciplinary study of computing away from the desktop or laptop. It draws from many areas of computer science, including: human-computer interaction (HCI), computer vision, digital signal processing, knowledge-based systems, distributed systems and networking. The research also draws on the theories and tools of psychology, sociology and anthropology, and derives inspiration from art and design disciplines when exploring new horizons.

At Dalhousie, Derek Reilly and his students are exploring applied ubicomp scenarios within healthcare and heavy manufacturing. They are also developing and evaluating new technologies to support healthy activities such as going for a run, maintaining a good posture at the office, or whole body interactive gaming.

“I believe that interdisciplinary collaboration is critical in order to build compelling ubicomp experiences,” says Dr. Reilly “and to convert these experiences into research outcomes.”

Students playing Tweetris, a game used to elicit and examine whole body interaction styles.
An example of this type of collaboration is Tweetris, an interactive art exhibit involving faculty and students from Dalhousie, University of Toronto and OCAD University (OCAD U). Visitors play a friendly game of full body “Tetris brick” (or tetromino) making. As tetrominos are created, a video snapshot of the person making the shape is tweeted to @TweetrisTO. The tweeted tetromino snapshots are then, used in a game of Tetris which other visitors can play, in real-time, by using their mobile phones or a wall-projected kiosk next to the main exhibit.

Tweetris has been used to contribute to our understanding of how setting impacts whole body interaction, and how low fidelity cues (such as tetrominos) can elicit whole body interaction styles from users without prematurely constraining them; a very useful approach for designers of these types of systems. Tweetris has been exhibited at art events and both gaming and HCI conferences.

Limber is another great example of interdisciplinary research collaboration, with Kate Hartman and Emma Westecott of OCAD U. Limber explores how gaming elements and ambient feedback can promote healthy behaviours within office environments. Jokingly described as “the gamification of sitting down”, Limber tracks a person’s seated posture over the span of a day. It periodically rewards the player with “Limber points”, or penalizes them with “Un-Limber points”. Players also accumulate points for stretching and getting up off of their seats.

This summer, Dr. Reilly is working with a team of students from Dalhousie Faculty of Computer Science (FCS) and OCAD U to develop an ambient device that gives unobtrusive feedback about these behaviours and visualizations. This enables office workers to track their performance over time, to compare their scores with those of their colleagues and to view the cumulative score of their workgroup in relation to that of another group. The team will be studying how these different motivators influence behaviour by deploying Limber in several targeted office environments.

A recurring theme in all of Dr. Reilly’s research is the blending of physical and digital. In another project involving Boeing and other FCS faculty, Dr. Reilly’s students are exploring ways that mobile devices can be used to query and explore relationships between paper documents and other surrounding objects, inspired by techniques from desktop information visualization.

He has developed a toolkit for blending these physical and virtual worlds called TwinSpace. “This allows people to meet and collaborate across distances without resorting to talking over a video-conference window,” he says. “It allows collaborators to move fluidly between different workspaces—a whiteboard and a conference table, for example—with-out losing contact with those connected remotely.”

TwinSpace has shown promise in controlled studies and demos, but has yet to be deployed “in the wild”. Over the next two years, this technology will be adapted to a very distinct applied context: a Brazilian care facility, serving people with neurological disorders. Researchers will explore how it can be used to support impromptu staff meetings, and when transitioning patients into independent living.

As ubiquitous computing enters the mainstream, the work of researchers like Dr. Reilly becomes more immediately relevant. By exploring new opportunities for ubiquitous interaction, Dr. Reilly and his students hope to find ways to augment—rather than overwhelm—our everyday lives.
A great deal of film, television, gaming and various interactive simulators are now computer generated, but realistically simulating natural phenomena has been a continuous key challenge in computer graphics. Many animated movies no longer have artist painted skies, but showcase a realistic storm—or clouds—by computer program generation. The fact these films can look at all realistic is due to the achievements that have been made within the field of computer graphics.

Water is a particularly difficult natural phenomenon to mimic, as it is visually complex and constantly in motion. Generating ocean surfaces in real-time is complex because a person simultaneously wants to see far into the distance (large scale) while also clearly seeing fine details up close (small scale). Handling one or the other of these instances is not computationally expensive, but handling both requires the generation of a vast amount of visual information.

A statistical wave model is a common method of synthesizing ocean appearance. It is built up from wave frequencies that have been sampled with buoys from real oceans. These frequencies can then be converted into spatial waves using an inverse Fast Fourier Transform (FFT). Naïve methods typically rely on large Fourier grids to generate a very wide range of detail, from the very small to the very large. Real-time requirements severely limit the size of the grids that can be used, even if the FFT is implemented on the Graphics Processing Unit (GPU). Due to this, no grids that have been used to date are sufficient for capturing the entire dynamic range of ocean waves, which can easily span four to five orders of magnitude.

Undergraduate research students Graham LeBlanc and Andrew Shouldice are working with Dr. Dirk Arnold and Dr. Stephen Brooks, of the Faculty of Computer Science, to develop a multi-scale approach that removes the FFT as the computational bottleneck of sea surface simulations. They split the full range of wave sizes into a small number of relatively narrow bands. The FFT can be used to transform each of the bands, and the final synthesis occurs in the spatial domain. A wide range of wave sizes can be modeled at a small fraction of the computational cost, making the algorithm highly suitable for real-time applications such as computer games or simulators.

The image below is an example of the multi-band simulation that uses four 64 by 64 Fourier grids that span a dynamic range of more than four orders of magnitude. It incorporates a wide range of wave sizes from the large, smooth waves to the small, detailed waves. The simulation runs at over 200 frames per second on current hardware. This is a much higher frame rate than is necessary for an interactive application and can be run at a lower frame rate to free computational resources for other application-specific tasks.

“This new approach will bring Hollywood-quality ocean rendering to your laptop,” says Dr. Brooks.

A video simulation of ocean rendering can be seen here: http://web.cs.dal.ca/~sbrooks/projects/oceanRendering/
For Christian Blouin, the rewards of teaching are simple. “I like to find a way to explain difficult concepts by way of example and analogies,” he says. This attitude earned him the first-ever Dean’s Teaching Excellence Award, an honour bestowed by the Faculty of Computer Science (FCS) for Dr. Blouin’s efforts in the classroom and for his brainchild, Daedalus: a software system for curriculum mapping.

**Charting a course**

Dr. Blouin has been teaching in the Departments of Computer Science and Biochemistry for almost a decade now, joining FCS in 2003 after completing his PhD at Dalhousie. Dr. Blouin is grateful for the environment in which he works, finding inspiration among his colleagues. “There are many others—both in computer science and in biochemistry—who are passionate about teaching,” he says. Dr. Blouin gave back to his fellow faculty members by creating Daedalus, a system that maps curriculum by dividing the content of courses and programs into individual tasks to teach. Daedalus also relates tasks to one another and associates them with student learning outcomes.

Michael Shepherd, Dean of FCS, believes that Daedalus “should lead to better courses across the entire curriculum for the students.”

**Pointing people in the right direction**

Dr. Blouin’s work with curriculum mapping and student learning outcomes ties into his teaching philosophy: that a positive student response is key to successful instructing. “Teaching should be a dialogue with students,” he explains. “Otherwise, teaching is simply going over a laundry list of learning outcomes. I see our role as instructors to explain to students why they want to know about different things. Once they know why something matters, learning happens (almost) without effort.”

His faculty profile provides a long list of research interests, publications and conference presentations, ranging from protein evolution to high-performance computing to geometry. Dr. Blouin speaks about his work modestly: “I do a bit of a lot of things.” He admits that he has a full plate, but believes that it’s a good problem to have when there are so many opportunities available at once.

**Going the extra mile**

During the past academic year, Dr. Blouin taught two new first-year informatics classes and was very pleased with the student response. “I make a point to know students in my course,” he says, “even if there are 80 of them. I try to treat my students like co-workers and see them progress throughout their degree even after I’m done teaching them.”

Dr. Shepherd describes an excellent professor as someone who takes the passion for education outside of normal work hours. “What most people do not understand is that to be a great teacher in the classroom requires a huge amount of preparation before you even get close to the classroom,” he says.

A selection committee composed of the associate dean academic and three faculty members chose the recipient for the new award based on components that demonstrated innovation and excellence, including student teaching evaluations.

In the coming school year, Dr. Blouin will co-teach two first-year classes titled, “Concepts of Computing”, and “Applications of Computing”, as well as a bioinformatics course. He will also offer an upper-level seminar in bioinformatics.

When asked, he offers the following analogy for the secret to successful teaching: “It is about selling exciting problems. You open the box of Lego, explain what each block looks like, how they fit together and ask [students] to make something awesome with it.”
The Faculty of Computer Science is pleased to announce the renewal of two Tier II Canada Research Chairs. The Canada Research Chairs Program is funded by the federal government and forms part of a strategy to make Canada one of the world’s top countries in research and development. This issue we talk to Rob Beiko.

1. What is your line of research?
I work in bioinformatics, which fuses computer science (CS) and biology to try and gain a better understanding of the living world. Bioinformatics is actually a very broad discipline that brings in people from different backgrounds including CS, biology and statistics; my background is mostly biological so I’m very interested in using the techniques we develop to answer some big questions that are on the board right now. For the past few years, I have been focused mainly on the ways that different microbes interact with one another in the short (ecological) and long (evolutionary) term.

2. How did you get interested in that?
While microbiology has been around for over 300 years (and some would say over 3000 years), in the past 20 years an amazing thing has happened. In the past, understanding even one particular kind of microbe required extensive experimentation in the lab, trying to grow it in culture and performing time-consuming and technically challenging experiments. In the 1990s, DNA sequencing technology exploded and all of a sudden you had information about the entire genome of an organism, all its DNA, and all its genes, as a complement to what was possible before. The resulting mountain of sequence data caused bioinformatics to take off, as scientists struggled to make sense of billions of letters of DNA. When I started my undergrad at Dal in 1994, a total of zero microbial genomes had been sequenced; in 1998 when I started my PhD, there were maybe a dozen; and in 2003 when I started my postdoc, there were just shy of 150. As of last count there are over 3000 available. Now, people are studying whole communities of microorganisms by sequencing everything all at once. This makes the bioinformatics tasks even harder, but can lead to some pretty exciting discoveries. Microbes are vital to the cycling of nutrients in the environment, can make us sick or keep us healthy and can clean up even the harshest of contaminated sites. What’s not to like?
3. What do you hope to achieve in the next 5 years?
One important focus of my research has been the process of lateral gene transfer (LGT) or the “sharing” of genes between microbes. If the best you can do, evolutionarily speaking, is to inherit everything from your parent or parents, then your ability to exploit new food sources, move into new habitats or deal with threats in your current habitat will be limited because you (or, more to the point, your children’s children’s children’s...) will need to invent the genes to do what you need. LGT changes this completely. If you find yourself suddenly bathed in antibiotics, you might stand a chance of picking up the resistance trait from someone else in the environment. We have been mapping out the big questions in LGT (who shares with whom? How often do genes get shared?) for several years, but with people now sequencing whole communities of microbes, we will be able to ask really focused questions about which genes have been shared, say, in the human gut or in contaminated soils. The early discoveries in the area have been pretty exciting, but making the most of these data sets will require more work on our part.

Another new area we’re involved in is DNA-based biomonitoring. The basic idea is that you can monitor an ecosystem’s health by focusing on the plants, animals and microbes you find there: one observed set of species might mean “healthy” whereas another might mean “uh oh, we’re in trouble”. People have been doing biomonitoring for years by taking samples and painstakingly trying to identify every insect, every plant part, and so on, in every sample. All of these organisms contain DNA, and some of that DNA can be used for identification purposes. We are putting the pieces in place to run the gamut including sample collection in remote locations, DNA sequencing, bioinformatics and GIS analysis of the resulting samples. We’re piloting this type of procedure in Wood Buffalo National Park, but hope to expand to many other locations over the next five years.

4. Who else is involved in this work?
The real work is done by the people in my lab—who develop the software and analyze the datasets that are generated by our collaborators. My group covers a diverse range of backgrounds, including software development, algorithms and visualization people, biologists and biochemists, statisticians and even a physicist or two. The basic rule of working in my lab is that you have to come in knowing something relevant, whether it’s CS, biology, math or stats, and be willing to pick up the rest.

I’m also fortunate to have a wide network of collaborators here at Dal, nationally and internationally. As a CS faculty member with a primary background in biology (although I did minor in CS!), my expertise is complementary to that of a lot of my colleagues. We have worked together to develop new algorithms and software that are targeted at the kinds of questions I am interested in. We don’t actually do environmental sampling, DNA sequencing or lab work ourselves, so it has been a huge advantage to team up with collaborators at places like U of T, Guelph, UBC and elsewhere around the world to directly tackle microbial questions with relevance to human health and the environment.

5. What attracts your interest outside of your research?
I have always been obsessed with maps and subjects related to them: history, exploration and geography. One of the great things about being a researcher is the ability you have to merge your outside interests with your research. I have been able to bring maps into the world of microbes and genomics. So maybe that’s not an “outside interest” after all! I was a voracious reader back when I had time for it. These days, I read more books but fewer words overall: trading big, ambitious trilogies for Dr. Seuss will do that. I love to play and listen to music. I’m no Jimmy Page or Jack White, but when I’m playing for my boys they don’t seem to mind.

Showing the association of related groups of kangaroo apple species with different regions of Australia using GenGIS 2.0.
“On way to Learning Commons at library. Web says they have study space avail for group work. Meet you there to work on our project?” texts a Dalhousie student to her group.

“My daughter goes to the Dalhousie daycare. I love their updated website—it has a ton of info about their programs and events. You’ll love it, too!” emails a Dalhousie parent to a friend.

“I went online and registered for a course at the Nova Scotia Fire Fighter’s School and bought one of their coffee mugs while on there,” boasts one rural volunteer firefighter to another.

“I did some water quality evaluations for Clean Nova Scotia on the Sackville River and got the report of my results immediately,” shares one young eco-conscious volunteer to her peers.

“I discovered the website of this community-oriented church in my neighbourhood. It is just the thing I have been looking for,” says one north-end senior to another.

What do all these active web users have in common?

All the services, websites and apps they used to find, connect, engage and improve their communities were developed by Bachelor of Informatics students at Dalhousie. Through project classes, the Informatics program offers student consultants to a wide variety of clients during the three academic terms each year. Since the degree’s inception in 2006, these project classes have provided service to more than 50 non-profits, community groups, Dalhousie clubs and societies, and more. Each informatics student participates in at least five of these project experiences throughout their academic career.

Informatics students bring expertise in technical communication, website design, database creation and project management to assist clients in finding solutions to their computer or technology-based challenges. Students help their clients formulate a plan that often incorporates a web presence for the services they provide to the community, in a way that they can maintain on their own. Projects may include: feasibility reports, documentations, tutorials, training sessions and user manuals, ensuring that real-life work scenarios and tools are brought to the classroom.

By creating groups that integrate students from second to fourth year, the Informatics program takes an innovative approach to student project management. By allowing fourth year students to play a managerial role, groups mirror actual workplace dynamics. Team leaders are given task delegation responsibility and each student will further develop their own team leadership experience as they progress through their academic program. This approach prepares students for their three co-op work terms, as well as real-life scenarios of project management and workplace group dynamics. By mixing students across several years, the project course imitates a student’s future employment experience as they learn to work with individuals at all levels and on a wide variety of tasks.

To learn more about the Bachelor of Informatics program, or to get involved, send an email to informatics@dal.ca.

4th year Informatics student, Rick Read, helps Father John Morrell and members of St. Mark’s Anglican Church choose images for their new website.
Dal students show their ‘app’-titude
First annual Dal App Challenge

Nine Dalhousie student teams representing three faculties competed on March 28 for $1,500 in prizes at the first annual Dal App Challenge.

The Goldberg Computer Science Building was temporarily transformed into a Dragon’s Den-style event, with students pitching their apps in five minute turns to judges Ken Burt, vice-president finance and administration, and Carolyn Watters, vice-president academic and provost.

After an intense 90 minutes of presentations, questions and appeals to a crowd of students, staff and faculty, the judges deliberated and votes were cast.

Winning entries
The first-place winner was computer science student Nathan LaPierre, taking home $750 for his application, “Dalhousie Libraries”, which helps students find books and articles at Dalhousie libraries with the touch of a finger. The app provides the same amount of information as desktop searches but enables students to save search results and retrieve exact stack locations.

“DalOnlineMobile”, the brainchild of computer science students Mark Lewicki and Stu Penner, won the second prize of $500. This app was built to enhance current DalOnline class scheduling processes with a goal of using automated features, event add-ins and GPS capabilities.

The contest also included a People’s Choice winner, voted by faculty, staff and students who attended the event. The winners were Mohamad Saliman, Tomasz Niewiarowski, Xiaoyu Yu and Marek Lipzac for their team creation, “Mobile App for Dalplex Users,” an app designed to capture “all things Dalplex” from news to scheduling, registration, location and space availability in classes.

The judges also decided to give an honourable mention prize, of $250, to Connor Bell’s “Dalpha,” designed to support an interactive, social network for note sharing and chatting amongst peers within the same Faculty or class.

Impressive output
Dr. Watters was impressed with both the quality and functionality of all apps presented, especially given the competition’s short one-month time frame.

“Ask Dalhousie students to come up with apps for Dalhousie students and give them a month during the term when they are already busy and what do you get? Incredible ideas that work,” she said after the event. “I was totally impressed with the imagination, innovation and compelling presentation of ideas from these students.”

Other participants in the competition presented apps for managing monthly budgets, tracking project schedules and organizing student societies. The goal of the competition was to showcase student creativity, though the organizers’ hope that some of the proposals will inspire further app development for use on campus.

Asked what advice she had coming away from the event, Dr. Watters’ response was simple:

“Don’t miss the Dal Apps Challenge next year.”

First Place Winner, Nathan LaPierre, with Judges Mr. Ken Burt and Dr. Carolyn Watters, and Associate Dean Dr. Denis Riordan
Outstanding Science
Science Atlantic honours Dal alumnus and former CS professor

An outstanding Dal alumnus
Erik Demaine was an outstanding student from the start, enrolling in Dalhousie at age 12 and completing his BSc in Computer Science when he was 14.

Dr. Demaine doesn’t remember ever feeling like an unusual student. “I fondly recall hanging out with my fellow students in the computer science lounge, watching and adlibbing episodes of Star Trek on a TV with the volume muted,” he says.

Now, he’s been honoured with an induction into the Science Atlantic Hall of Fame as an Outstanding Student. Science Atlantic (formerly APCS), celebrating its 50th anniversary this year, has maintained a mission to “advance post-secondary science education and research in Atlantic Canada,” offering opportunities to students and support to educators through its annual conferences. The conferences include lectures, symposiums and competitions such as the Computer Science Programming Competition, in which Dr. Demaine participated.

In his third (and final) year at Dalhousie, Dr. Demaine attended the 1994 Science Atlantic Computer Science Conference and partook in the joint Math Conference as well.

“I played a lot of video games as a kid, and one day asked my dad about how people made them,” says Dr. Demaine. “Then we started exploring computer programming together, which led me to computer science.”

Dr. Demaine’s latest computer science research caused him to return to the game controller as he co-authored a paper titled “Classic Nintendo Games are (NP-)Hard,” which proves that even a computer cannot earn a perfect score in Super Mario.

After completing two graduate degrees at the University of Waterloo in 2001, Dr. Demaine became the youngest professor to ever teach at the Massachusetts Institute of Technology (MIT). As an author of four books, collaborator on close to 300 articles and other publications, and the co-director of a short film, he has not slowed down yet.

He credits the beginnings of his extensive research career to his undergraduate advisor Dr. Srinivas Sampalli, who encouraged him to write papers and give talks while at Dalhousie. Now, Dr. Demaine enjoys inspiring a new generation of young researchers. “I like the challenge of finding the simplest possible way to explain a difficult solution, often leading me to think about simplifying the solution itself,” he says.

“I also like the performance aspect of teaching—making material entertaining, funny and generally enjoyable.”

Although currently instructing courses in the Department of Electrical Engineering and Computer Science, Dr. Demaine has an impressive artistic résumé as well. Using his research background in folding algorithms, he has produced sculptures that have been displayed at galleries including the Museum of Modern Art and the Smithsonian American Art Museum.

“My dad’s background is in visual arts, and he saw the same kind of artistic creativity in the mathematics I was doing,” he says. “So he started doing mathematics with me, and then we started designing and building sculptures together using that mathematics. So the two fields evolved pretty closely for me.”

This summer, Dr. Demaine will be teaching alongside his dad at the Pilchuck Glass School, offering a class on glass folding. “The class is experimental, as we’re still figuring out all the many ways to incorporate folding (and all our experience with folding paper) into hand-blown glass,” says Dr. Demaine.

An outstanding CS professor
Dr. Art Sedgwick, who recently passed away, had been one of Erik Demaine’s first professors and taught him programming languages and algebra.

Dr. Sedgwick often said that, “Erik is a good example of the benefit of combining computer science and math.”

Dr. Sedgwick received recognition from Science Atlantic as an Outstanding Contributor. Science Atlantic also named their keynote lecture after the former chair of the Computer Science Committee. When he first became involved in Science Atlantic, computer science was
still part of the math department. The Math Committee had an annual competition and computer science followed suit, with Dr. Sedgwick helping to create problems for the programming competition.

Dr. Sedgwick had been very involved with the Computer Science Programming Competition and noted that, “many faculty in computer science have limited opportunity to do programming and enjoy being involved in the Computer Science Programming Competition,” adding that “the winners of the annual competitions are highly sought after by large multinational companies like Google, IBM and Microsoft.”

He believed that Science Atlantic provides students with the unique opportunity to collaborate with faculty on projects and present their research to an audience of peers, and that it gives students exposure to a wider world and our grad programs a place to recruit good students.

Snapshots


Adrien Adler, Julia Rivard and Carolyn Watters talk about “Strength Finding: Guiding Your Personal Brand” at the WiTS event, Girls Talk Tech – March 2012

Bachelor of Computer Science student, Sarah Morash, thanks the Goldberg family on behalf of each student scholar at the Schulich/Goldberg Reception – March 2012

Contributors
Allison Kincade, David Langstroth, Stephen Brooks, Katherine Wooler, Dirk Arnold, Derek Reilly, Norm Scrimger, Michael Shepherd, Robert Beiko

Principle Photography: Craig Buckley (cover story), Danny Abriel, Nick Pearce

Design: Design Services

Class Notes
Please send in any news, announcements, events or ‘things you’d like to see’ to Allison.Kincade@dal.ca. Stay connected with us online via Twitter.com/dalfcs and Facebook.com/dalfcs.

We’d love to hear from you!
Congratulations to all of our May 2012 Faculty of Computer Science graduates!

come home to Dalhousie
September 27–29, 2012

Just imagine who you might run into

Thursday, September 27
Dalhousie Alumni Dinner
6 p.m., McInnes Room, Dal SUB

Friday, September 28
Alumni Lecture - Dr. Sara Iverson
10:30 a.m., Studley Campus
President’s Reunion Lunch and Milestone Anniversary Class Photos
12-2 p.m., Shirreff Hall

Saturday, September 29
Lobster Tailgate Party and Dal Tigers, 1-6 p.m., Studley Quad and Wickwire Field

Visit dal.ca/homecoming for event details, tickets and registration.

Friday, September 28
Special events at the Faculty of Computer Science

5 p.m.: Lecture: “The Intersection of Smartphones, Cloud Computing and Near Field Communications: The Next Big Wave in Wireless” by Dr. Srini Sampalli
6 p.m.: Alumni & Friends Reception, alongside the CS Society Geek Beer

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Alumni & Donor Relations Officer
Faculty of Computer Science
Dalhousie University
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