THE FOUNDATION OF MODERN LIFE.

Department of Computer Science

Computing is not about computers any more. It is about living.

Nicholas Negroponte

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CS @ ILLINOIS

Department of Computer Science
College of Engineering, College of Liberal Arts & Sciences
University of Illinois at Urbana-Champaign

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MAGAZINE 2015, VOLUME II

> **" Computing underpins just about every aspect of modern life. The arts, science, business, medicine, and engineering all benefit. "**

The demand for and subsequent growth of computer science education has exploded, and there appears to be no slow-down in sight. That's because computing underpins just about every aspect of modern life. The arts, science, business, medicine, and engineering all benefit from the computational power, modeling, and thinking found in computer science. And not surprisingly, CS @ ILLINOIS faculty are bringing their expertise to bear on a variety of vexing issues in a wide range of fields.

One of those areas is medicine, where we expect to be a key partner for the campus's first new college in nearly 60 years—the first medical school in the nation focused, from the beginning, on the intersection of engineering and medicine. CS @ ILLINOIS will work with this new Carle Illinois College of Medicine to apply revolutionary advances in engineering and computing to patient care.

We're also excited that Google is funding two new initiatives in CS @ ILLINOIS. Through Mobile-First, supported by a $1 million Google Focused Research grant, Illinois will advance not only innovative research but also a compelling undergraduate curriculum for mobile and cloud computing. Additionally, Illinois is joining a cohort of national research universities funded by Google to enable effective use and broad adoption of the Internet of Things.

I am heartened to feature two new gifts from loyal CS alumni that will have an incredible impact on the future of our program. With a legacy commitment, Scott Fisher (BS Psychology '72, MS CS '76) will be creating an endowed faculty professorship, and CJ Desai (MS CS '95, MBA '95) is establishing an endowed fellowship to help women pursue CS graduate studies. Gifts like this are critical in recruiting and retaining the very best faculty and students.

Great things continue to happen in CS @ ILLINOIS— thanks to our incredible faculty, staff, students, and alumni.

Rob A. Rutenbar, Head and Abel Bliss Professor

ROBOT REVOLUTION

MSI's Robot Revolution Exhibit Features CS Professor Steven LaValle

BY RICK KUBETZ, COLLEGE OF ENGINEERING

Through January 3, 2016, the Museum of Science and Industry, Chicago (MSI) is showcasing a new national touring exhibit, Robot Revolution, that explores how robots, created by human ingenuity, will ultimately be our companions and colleagues, changing how we play, live, and work together.

The exhibit comes to life with a collection of cutting-edge robots that have been secured from some of the most innovative global robotics companies and universities. On video screens throughout the exhibit hall, technology pioneers explain why robotics is exciting, as well as the key challenges faced by researchers and developers in specialty areas such as manipulation, planning, and locomotion.

"I am honored to be a part of this amazing project and to help explain aspects of robotics to both kids and adults," CS Professor Steven LaValle said.

LaValle is one of the robotics scientists featured in the exhibit because of his contributions to motion planning. His Rapidly-exploring Random Tree (RRT) algorithm is a fast method to determine and plan a robot's actions. His textbook, *Planning Algorithms,* is available for free and has been downloaded over one million times.

LaValle's influence in the field led the founders of Oculus VR to approach him for help. As principal scientist for the company until its acquisition by Facebook, LaValle led research on head tracking methods and human factors issues in virtual reality.

See photos and video previews of the exhibit, explore the "for educators" materials, and buy tickets online at: msichicago.org.

Robot Revolution at the Museum of Science and Industry, Chicago, features CS Professor Steven LaValle and provides hands-on information and fun

Roger Dickey Shares Insight on Startups

BY TOM MOONE

Roger Dickey (BS CS '05) is an experienced and successful entrepreneur, and he enjoys sharing his insights to guide others. In 2007, he launched a social gaming startup, building apps and games for the (then) newly launched Facebook. In 2008, Dickey and his company were bought out by Zynga. He retooled an earlier game that he had created into Mafia Wars, which reached 45 million users by 2010. In three years at Zynga, Dickey also launched FishVille and five other titles. In addition, he served as an international product team advisor for Zynga, helping the company grow its games in India, Japan, and China.

Roger Dickey shared his experiences with startups with CS @ ILLINOIS students

Dickey is now a serial entrepreneur and active angel investor based in San Francisco. His latest venture is Gigster, a company that helps match companies with software developers.

During his Engineer in Residence presentation, Dickey shared highlights from both his Illinois experience and his career before a packed room of students in the Siebel Center. Throughout the Q&A portion Dickey kept coming back to some major themes that he wanted to emphasize to the students.

One of Dickey's emphases was the need to have a broad academic base. Dickey described his experiences taking classes in other engineering programs to expand his knowledge. "I took some electrical engineering. I did some mechanical engineering," Dickey said. "My objective, I guess, was to learn a lot of patterns from other departments in engineering that I could apply back into computer science. I didn't want to graduate just being a programmer. I wanted to be a true engineer—able to approach any problem and figure out how to create a solution to it."

CS @ ILLINOIS Engineer in Residence (EIR) Program

STUDENTS REALLY BENEFIT FROM THE REAL-WORLD EXPERIENCES THAT OUR ALUMNI HAVE TO SHARE.
As an EIR, alumni reside in the department for a day or more to help students develop their computer science education into valuable applications and successful careers. EIRs often give presentations, attend informal meetings with students and faculty, and hold office hours for students interested in more personalized advice. If you are interested in participating in the EIR Program, email Michelle Wellens at mwellens@illinois.edu.

Dickey said that this approach was beneficial to his career. "It helped me be a more creative software engineer. I would highly recommend taking classes outside your discipline," he said.

A second emphasis was the importance of involvement in projects outside the classroom, particularly for people who are interested in starting a company. "If you want a shot at being a founder, you should have experience doing a lot of projects," he said. "And it really helps when your teammates care about your project."

In addition to the learning experiences that can come with these projects, they can also develop lifelong connections to people who will remain close friends long after college. "Doing projects with people here is a fantastic way to build bonds with people that probably you'll have the rest of your life," he said. "Some of the strongest bonds I have are with the teammates I worked on freshman year EOH with, because we must have worked on that for two months on top of classes. I'm friends with those people to this day."

But Dickey was quick to point out that he was not saying that everyone should be a startup founder—in contrast to the prevailing feeling in Silicon Valley. Being the founder of a startup is not necessarily for everyone: "It's as hard as it's ever been to be a founder. Unless you think it's your true purpose to be a founder, there's nothing wrong with going on to be a software engineer at a great company. It's fun. It's a stable job. You'll be able to support a family."

For those who do decide to start their own companies, they need to realize that not every aspect of that is glamorous: "I have to do a lot of things I don't like to at my job. I have to design, I have to coordinate PR, I have to go to parties I don't necessarily want to go to."

Of his return to campus, Dickey said that it was making him nostalgic, and he almost wished he were still in school. "It's such a privilege to go to classes, and go to the lectures," he said. "While you are here, you definitely want to make the most of it."

From left: Joel Poloney and Amitt Mahajan

Alumni Startup Toro Acquired by Google

Toro, a startup founded by Amitt Mahajan (BS CS '06) and Joel Poloney (attended through 2007), has been acquired by Google. Formerly known as Red Hot Labs, Toro's aim was to make launching and optimizing a Facebook ad campaign as easy as possible for mobile app developers by automatically creating and testing "hundreds of variants" for each campaign.

"Three years ago, we set off on a mission to create tools for app developers that we always wished we had," read the announcement from Toro. "With greater resources and distribution now available at our disposal, we're excited to join Google and continue our mission of making the lives of app developers easier."

With this acquisition, though, the company will divert its focus from Facebook to other opportunities.

Prior to Toro and Red Hot Labs, Mahajan and Poloney were among the cofounders of MyMiniLife, the company that, as it was in the process of being acquired by Zynga, started the development of popular Facebook game Farmville in 2009.

Alumni Startup Lumenous Takes it to the Next Level

BY TOM MOONE

Lumenous, a startup founded by CS alumni Kevin Karsch (PhD CS '15), Brett Jones (BS CS '08, MS '10, PhD '15), and Raj Sodhi (BS CS '08, MS CS '10, PhD '15), has received a Small Business Innovation Research (SBIR) grant from the National Science Foundation (NSF). This grant is designed to help Lumenous in creating tools to make projection mapping more prevalent and affordable.

Using video projectors, projection mapping overlays digital content onto physical objects and allows viewers to experience and interact with digital experiences in a new way. The content could be still images or video.

The Industrial Innovation and Partnerships Division of the NSF, which has provided the funding for Lumenous's SBIR, invests in science and engineering research across multiple disciplines that have the potential for high impact in meeting societal and national needs. It leverages federal, small business, industrial, university, state, and community college resources.

The Lumenous team will use this grant to develop a novel software and hardware system for authoring projection mapping content. The proposed system will greatly simplify a currently complex content authoring process, and will enable entirely new passive and interactive experiences which fuse digital content with the physical environment.

"The NSF SBIR Phase I funding, in addition to the Cozad competition, was instrumental in getting Lumenous off the ground," said Jones. "We are even more excited that it leads to an opportunity for $1.25 million in additional funding through the Phase II grant. We are excited for what is yet to come."

The company's stated goal is to reinvent projection mapping, making it easier, cheaper, and more powerful than ever before.

The company won the 2014 Cozad New Venture Competition at the University of Illinois. And the founders are all individual winners for innovation. Karsch won the Lemelson-MIT Illinois Student Prize in 2012, and Jones and Sodhi each received an Illinois Innovation Prize for separate projects in 2013.

Lumenous—founded by (from left) CS alumni Raj Sodhi, Kevin Karsch, and Brett Jones—wants to make projection mapping easier, more powerful, and more affordable.

To see current uses of projection mapping, check out this amazing video: http://bit.ly/1KhywtM
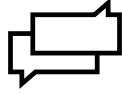
Ashby Named Director of PNNL

Steven Ashby (MS CS '85, PhD '88) has been named laboratory director for the Pacific Northwest National Laboratory (PNNL) in Richland, Washington. One of ten U.S. Department of Energy national laboratories, PNNL employs 4,300 staff with an annual budget of $1 billion.

Ashby has served as PNNL's Deputy Director for Science and Technology since 2008. He was instrumental in integrating PNNL's science and technology capabilities to address critical challenges in science, energy, the environment, and national security. He is widely recognized as a leader in computational science and has worked to advance it as a discipline throughout his career.

Ashby is a member of the American Association for the Advancement of Science, and was elected AAAS Fellow in 2013. He was elected to the Washington State Academy of Sciences, and serves on the Science Policy Committee of the Society for Industrial and Applied Mathematics (SIAM).

Mark Tebbe to Lead ChicagoNEXT

Mark Tebbe (BS CS '83) has been named chairman of ChicagoNEXT, World Business Chicago's council of technology leaders representing a dedicated effort to drive growth and opportunity in the areas of science, technology, innovation, and entrepreneurship for startups and later-stage growth companies in Chicago's rapidly growing ecosystem.

Tebbe has over 25 years of experience as an entrepreneur and as founder of two NASDAQ-listed corporations, Lante and Answers.com. Now an Operating Executive with Lake Capital, a $1.3 billion private equity firm, he guides and aids numerous portfolio companies with strategy development, operational refinement, execution monitoring, as well as investment evaluation, structuring, and negotiation.

Tebbe is on the executive committees for 1871, one of Chicago's top tech incubators, and TechNexus, a venture collaborative. He is also Entrepreneur in Residence and Adjunct Professor of Entrepreneurship at the University of Chicago Booth School of Business. This spring, Tebbe returned to campus to give a keynote address at the University's Entrepreneurship Forum, where he also helped judge the Cozad New Venture Competition.

ChicagoNEXT is an arm of World Business Chicago, a public-private partnership that works to engage businesses and civic leaders to advance economic growth in Chicago.

Criswell Receives Honorable Mention for 2014 ACM Doctoral Dissertation Award

BY LAURA SCHMITT

John Criswell

John Criswell (BS CS '03, PhD '14) received an Honorable Mention for the 2014 ACM Doctoral Dissertation Award in June for developing a Secure Virtual Architecture for commodity software systems. A member of CS Professor Vikram Adve's research group, Criswell investigated security issues related to the operating system (OS) kernel, which is the foundation upon which all application software is built.

According to Criswell, an attack on the OS kernel allows a hacker to modify the behavior of any application. The system architecture he introduced in his thesis is the first to provide strong automatic protection for a commodity OS kernel like those found in Linux or FreeBSD. Specifically, his compiler-based approach enforces strong guarantees such as memory safety and control flow integrity of the kernel to protect it from buffer overflow attacks, which can also afflict applications. He then adapted these techniques in a system named Virtual Ghost

Criswell's introduction to software security began more than a decade ago when he was a software engineer with Argus Systems Group, which is now part of General Dynamics C4. At Argus, Criswell enhanced the AIX operating system kernel and wrote utilities that utilized mandatory access controls to improve system security.

After working at Argus for six years, Criswell worked as a research programmer in Professor Adve's group before deciding to pursue his doctorate. "I saw all the fun the grad students were having, and thought I wanted to be a part of that," said Criswell, who was grateful for the opportunity. "Professor Adve was very good at getting me to go beyond the boundaries of what I thought I could do. He was always enthusiastic and excited about the work. That always made [me] want to do more."

Today, Criswell is an assistant professor of computer science at the University of Rochester, where his

"I saw all the fun the grad students were having, and thought I wanted to be a part of that."

to allow applications to continue running securely even if the OS kernel is compromised by other means, such as by malicious kernel drivers. "My approach assumed the OS kernel was compromised, and it allowed applications that don't want to trust the kernel to operate securely regardless," Criswell said.

research focuses on computer security and automatic compiler transformations to enforce security policies on commodity software.

This ACM recognition isn't the first such distinction for Criswell. Last fall, he received the Honorable Mention for the 2014 Special Interest Group on Operating Systems (SIGOPS) Dennis M. Ritchie Doctoral Dissertation Award. In October, he will receive the David J. Kuck Outstanding PhD Thesis Award at the CS @ ILLINOIS Awards Ceremony.

Roy Choudhury Receives SIGMOBILE RockStar Award

BY KATIE CARR, COORDINATED SCIENCE LAB

ECE Associate Professor and CS @ ILLINOIS alumnus Romit Roy Choudhury (PhD CS '06) was recently awarded the 2015 ACM SIGMOBILE RockStar Award in recognition of "significant contributions, early in his career, to mobile sensing and wireless

Roy Choudhury has recently been working with sensors embedded in smartphones, smartwatches, and other wearable devices. Projects include indoor localization, activity and gesture recognition, Internet of Things (IoT) and various forms of augmented reality.

> **The RockStar award should actually go to my students… who have passionately plunged into research and courageously taken on bold projects. They are an awesome rockband and I am always excited to jam with them.**

networking, with an emphasis on location and cross-layer protocols." He was presented the award at the 2015 ACM Conference on Mobile Computing and Networking (MobiCom) in Paris.

"It is an honor to receive this award and a validation that things we are trying in our labs are perceived as important and impactful by the wireless and mobile research community," said Roy Choudhury, who is also a researcher in the Coordinated Science Lab. "The award also gives us a cushion to not worry about failures as much and to be able to take bigger risks in our research."

Roy Choudhury's main areas of work are in wireless networking and mobile computing, and in recent years, he has focused on doing what he calls "top-down research."

"We try to envision different systems or technologies for the future and break them down into their building blocks to determine what the missing pieces are today," he said. "We research and develop these missing pieces and glue them back together to build the end application."

"In our work, we treat the various sensors as a multidimensional opportunity to understand position, environment, behavior, and numerous other human contexts in daily lives," Roy Choudhury said. "Applications are diverse, including navigation, mobile healthcare, smart cities, smart cars, privacy and security, entertainment, advertisement, and others."

Roy Choudhury believes that the percolation of sensors in personal devices and in our surroundings can be metaphorically explained as "information lenses" that offer diverse perspectives of the physical world. When the data from these lenses are aggregated in the cloud, the collaborative insights can be extremely powerful.

Roy Choudhury received a 2013 Google Faculty Research Award, 2007 NSF Career Award, 2009 Hoffman Krippner Award for Innovations in Engineering, and 2015 HotMobile Best Demo award.

"The RockStar award should actually go to my students, both former and current ones, who have passionately plunged into research and courageously taken on bold projects," Roy Choudhury said. "They are an awesome rockband and I am always excited to jam with them."

Professor Romit Roy Choudhury

In Memory: Gregory Chesson, 1945-2015
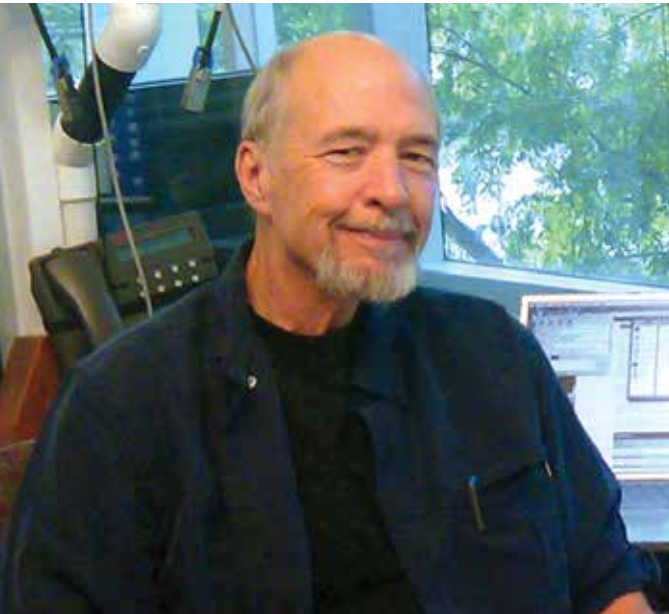
It is with sadness that CS @ ILLINOIS notes the passing of alumnus Gregory Chesson (MS '75, PhD '77) on June 28, 2015. He was 69.

Chesson spent much of his career as chief scientist with Silicon Graphics Inc. (SGI), the maker of powerful computer workstations and servers whose realistic 3D graphics technology was popular among movie, game console, and early Web companies during the 1980s and early 1990s. He has sometimes been called the godfather of networking due to his many contributions to the area.

As a student at Illinois, Chesson helped bring the UNIX operating system to campus by convincing Professor Donald Gillies to purchase a license. After graduation, he joined Bell Labs, where he contributed to the 6th and 7th releases of UNIX. In 1982, he joined SGI as one of its first technical staff members. Among his contributions was the invention of the Xpress Transfer Protocol (XTP), a flexible transport protocol designed for high-speed networks.

In 2000, Chesson joined Atheros Communications Inc., contributing to wireless chip designs, and in 2005 he joined Google, where his work focused on measurement and analysis of large-scale congestion and packet burst phenomena.

Chesson received the Distinguished Alumni Achievement Award from CS @ ILLINOIS in 2012, and the College of Engineering Alumni Award for Distinguished Service in 2014.

Agarwal Named Radcliffe Fellow

Shivani Agarwal (PhD '05) was named recipient of Harvard University's illustrious Radcliffe Fellowship. The Radcliffe Institute Fellowship Program annually supports the work of 50 scholars, scientists, artists, and writers of exceptional promise. It is an exclusive program, with an acceptance rate of just 3 percent.

Agarwal is currently an assistant professor and Ramanujan Fellow in the Department of Computer Science and Automation at the Indian Institute of Science where she leads the Machine Learning and Learning Theory Group and co-directs the Indo-US Joint Center for Advanced Research in Machine Learning, Game Theory and Optimization.

Her research focuses on machine learning and learning theory, in particular, the study of ranking and other complex learning problems.
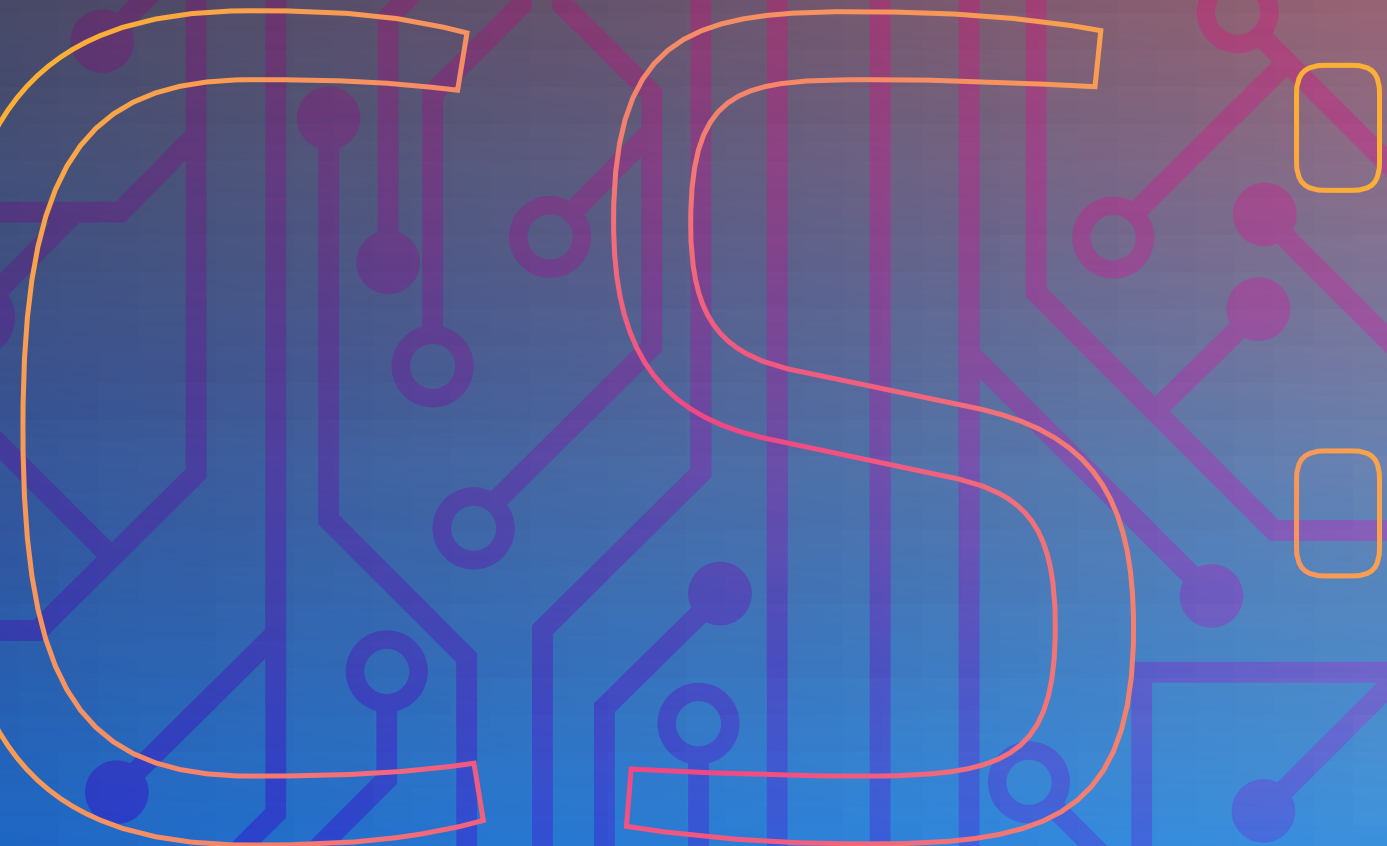
THE FOUNDATION OF MODERN LIFE.

BY LAURA SCHMITT

In what single University of Illinois department would you find faculty research ranging from construction site optimization, to social media algorithms, to bee genomes and evolution, to simulating how diseases spread? In CS @ ILLINOIS, of course—and for good reason.

Computer science underpins just about every aspect of modern life. The arts, science, business, medicine, and engineering all benefit from the computational power, modeling, and thinking found in computer science. And not surprisingly, CS @ ILLINOIS faculty are bringing their expertise to bear on a variety of vexing issues in a wide variety of fields.

ONE OF THE MOST costly issues related to major construction projects is the allocation of labor. "Right now, only about 50% of construction labor costs are productive," said CS Associate Professor Derek Hoiem. "About half the time, labor is idle because of how hard it is to schedule where people should be."

Construction managers are limited by how quickly they can reallocate their workers because most construction progress data is compiled manually. "Management can only respond to delays on a weekly basis, which ends up creating large delays over time that are very costly," explained Hoiem, who is working with fellow Illinois engineering faculty on a novel autonomous vision-based robotic solution to monitor construction progress more quickly and cost effectively.

CONSTRUCTION SITES

Professor Derek Hoiem

A computer vision expert, Hoiem is developing robust and rapid 3D reconstruction techniques to model the construction site based on images and video streaming from cameras strategically placed throughout the site by a quadcopter. He then aligns the 3D model with the planned model to automatically detect deviations.

Using technology developed by Derek Hoiem's and Mani Golparvar Fard's groups, a building's 3D planned model is overlaid on the 3D point cloud reconstructed from photos of the actual construction site. The tasks that are likely to fall behind schedule are highlighted in yellow.

"We can then identify parts of the construction that are behind schedule," Hoiem said. "That would allow the managers to quickly reallocate resources in order to bring things up to speed."

With funding from NSF, Hoiem and his colleagues—Civil Engineering Professor Mani Golparvar-Fard and Aerospace Engineering Professor Tim Bretl—are collecting data from a residence hall construction site on campus and at the new $500 million Sacramento Kings basketball stadium project in California.

According to Hoiem, the computer vision field has taken off in the last few years as techniques have become more robust and reliable. "Applications of the technology range from entertainment, to surveillance, to automated driving—anything where you want a machine to understand the world," he said. "This is a very exciting time for computer vision."

> **We can identify parts of the construction that are behind schedule. That would allow the managers to quickly reallocate resources in order to bring things up to speed."**

SOCIAL MEDIA

WHEN KARRIE KARAHALIOS was growing up, she recalled her father climbing on the roof to adjust the TV antenna when a soccer game was on. "We didn't understand electromagnetism or wave propagation, but we did see cause and effect—move the antenna a certain way and get a better picture," said Karahalios, a CS associate professor.

Karahalios is taking the same approach to social media use. Through her research on human-computer interaction, she aims to inform people about algorithms that social media sites use and how they shape people's experiences—from what comes up in a Google or Yahoo search, to what Facebook users see in their news feed, to whether someone qualifies for a mortgage or auto loan. In essence, she's on a quest to help people manage their interactions on the Web.

"Some people aren't even aware of algorithms, and many people don't know how to modify their behavior to get the algorithm reception they want," said Karahalios, who recently published her research study on Facebook user habits and how they changed after people learned about the algorithms controlling their news feed.

In her study, Karahalios convened a demographically diverse group of Facebook users—nearly two thirds of whom did not know their news feeds were automatically edited. She ran each user's Facebook feed through her FeedVis tool, which showed all the content posted by their friends.

"Our research was the first to discover that, while companies assumed that people were aware of these algorithms, they were not," Karahalios noted. "Our research was also the first to come up with some design practices to make people aware of them."

People were shocked when they discovered that they had missed posts from a family member or close friend, said Karahalios. Several months later, she followed up with the Facebook users from her study and learned that many of them had changed their behavior. For example, some users now used the Facebook settings to view their feed chronologically, some users lost trust in their feed and began visiting their close friends and family members' Facebook pages directly to make sure they didn't miss any important news.

"We have a right to know how these algorithms work, but they are locked behind proprietary walls," she said. "People are coming up with complex strategies [to manage the algorithms], but the interfaces should support them."
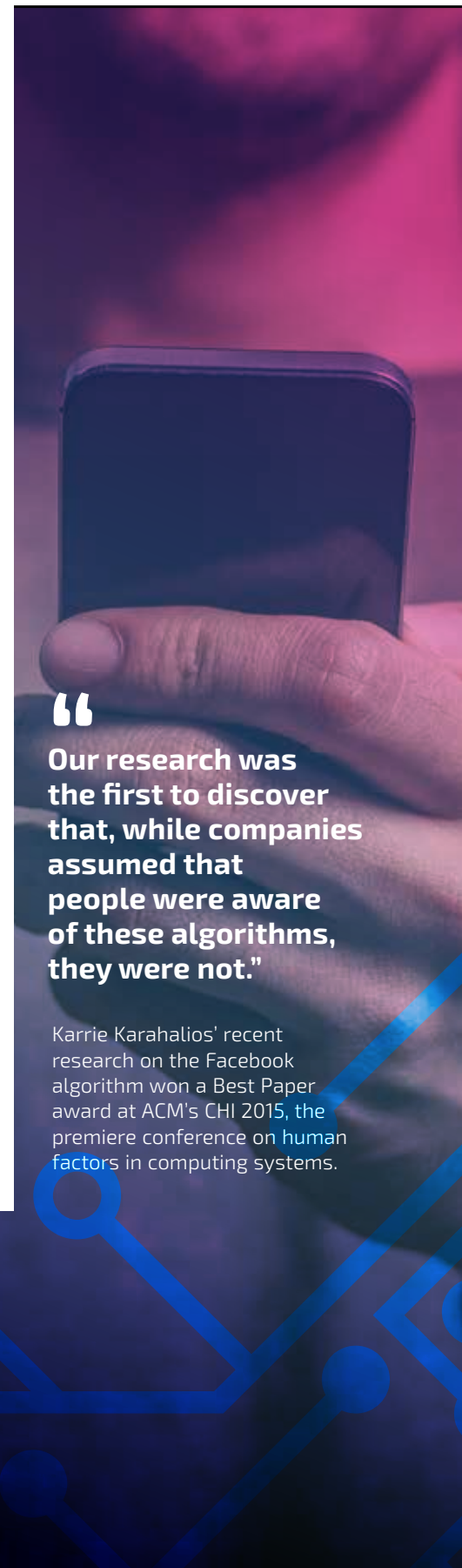
> **"**
> **Our research was the first to discover that, while companies assumed that people were aware of these algorithms, they were not."**
>
> Karrie Karahalios' recent research on the Facebook algorithm won a Best Paper award at ACM's CHI 2015, the premiere conference on human factors in computing systems.

Professor Karrie Karahalios

Professor Saurabh Sinha

> **Let's together find out what the questions are and how computing can help answer them."**

CS ASSOCIATE PROFESSOR Saurabh Sinha has created a number of computational tools for the academic community. One of them is genomic analysis software that uses the concept of hidden Markov models to score the presence of biologically important patterns called transcription factor motifs in DNA.

Recently, he used the software to help an international team of researchers discover that gene regulation, or the process of turning genes on and off, underlies the evolution of social complexity in bees. This discovery, which was published in the June 5, 2015, issue of *Science*, provides new insights into the genetic changes that accompany the evolution of bee societies—something that scientists have tried to understand for more than a century.

Sinha and his colleagues, including Illinois Entomology Professor Gene Robinson, used software to analyze the genomes of 10 different bee species, identifying biologically meaningful patterns in their DNA. According to Sinha, an increase in the presence of a particular pattern near a gene indicated a more socially complex bee colony.

BEE GENOMES

During the last 10 years, Sinha has made other important contributions to understanding the gene regulatory process by working with Robinson and other faculty at the Carl Woese Institute for Genomic Biology (IGB) on the Urbana campus. For example, Sinha conducted a computational analysis of gene regulatory relationships in three different species (house mouse, stickleback fish, and honey bee), enabling his fellow IGB colleagues to conclude that animals not only share genes for some common physical traits but may also share a genetic toolkit for behavioral traits as well.

According to Sinha, the merging of computer science and other disciplines is a welcome change, due in part, to well-trained computer scientists moving out of their core research area and learning about a very different domain of inquiry.

"The attitude towards interdisciplinary work has started changing from one of 'send me your data and questions, and I will build a method to solve them,' to the much more effective attitude of 'let's together find out what the questions are and how computing can help answer them,'" he said. "In other words, the big change is in the minds of people."

> **This could be a great tool in the hands of public health officials."**

WORKING WITH LEAD RESEARCHERS at Virginia Tech University, CS Professor Laxmikant "Sanjay" Kalé is helping discover how contagions like the H1N1 and Ebola viruses propagate through populations. Their EpiSimdemics project simulates the spread of an epidemic in extremely large and realistic social contact networks, capturing dynamics among co-evolving entities.

In addition, their simulation model can analyze what-if scenarios, such as predicting the effect that closing schools or broadcasting precautions to the public would have on the spread of the disease.

"This could be a great tool in the hands of public health officials," said Kalé, noting how an increasingly urban and mobile population enhances the chances of a future worldwide pandemic.

Solving a complex problem like this requires serious computing power, and, more importantly, sophisticated parallel applications capable of exploiting that power. Kalé recognized that automating resource management is a key to simplifying application development, which led to the design of the Charm++ adaptive runtime system. Charm++ is available via the Web so other scientists can develop new applications for large-scale simulations.

Kalé started developing Charm++, which is based on the C++ programming language, nearly 20 years ago, in order to make it easier to develop software for supercomputers, while enabling efficient utilization of the machines. He and his research group have continued to develop, improve, and evolve the system based on feedback from collaborative application development.

"We have been working a long time to develop a really powerful parallel programming system," Kalé said. "Charm++ is one of the few academic software systems that has had impact and sees actual use in applications on supercomputers."

One such application was a collaboration with Illinois Biophysics Professor Klaus Schulten several years ago in developing Nanoscale Molecular Dynamics (NAMD) software. Recently, NAMD was used by Schulten and collaborators in the world's first simulation of the precise chemical structure of the HIV capsid. Kalé's simulation code accounted for the interactions of 64 million atoms.

From top: Sanjay Kalé (left front) and members of his Parallel Programming Laboratory are pictured with attendees at the annual Charm++ applications workshop held on campus in May 2015; HIV Capsid.

DISEASE PROPAGATION

According to Kalé, more than 70,000 researchers have used NAMD to conduct a variety of biophysical studies. Kalé's group has created other scientific applications built with the Charm++ system that enable astronomers to study the origins of the universe (ChaNGa) and engineers to study quantum-mechanical details of photovoltaic materials (OpenAtom), which may lead to better solar cells.

"We are not experts in quantum chemistry or astronomy or epidemiology," he said. "Our expertise is in parallel programming and how to make parallel computing easy and efficient for scientists and engineers who want to develop these kinds of models."

ENGINEERING-BASED COLLEGE OF MEDICINE

Biobots that deliver medicine directly to infected cells. Flexible electronic sensors that dissolve when their job is done. Microscopic stents that can speed and direct neuron growth.

These are just some of the biomedical and engineering innovations that are already made possible by researchers at the University of Illinois. And they're part of the inspiration for a new Carle Illinois College of Medicine at the University of Illinois at Urbana-Champaign.

This new college—the campus's first in nearly 60 years—will be the first medical school in the nation focused, from the beginning, on the intersection of engineering and medicine. Students will be immersed in the experiences that merge clinical education and engineering from Day One. The College's impact will be felt by future patients of this new kind of doctor, and people around the world will benefit from the discoveries made by these physician scientists and medical innovators.

The College of Medicine will leverage many strengths of the University of Illinois, including expertise in bioengineering, big data, and high-performance computing, to enhance the health of patients in the real world. It will also leverage the research capabilities of interdisciplinary units such as the National Center for Supercomputing Applications, the Beckman Institute for Advanced Science and Technology, and the Woese Institute for Genomic Biology.

Engineering programs with deep, thriving connections to medicine and healthcare are the future. And Illinois' College of Engineering is already leading the way as home to fifteen Top 5 ranked programs. CS @ ILLINOIS will be a key partner in this new endeavor as revolutionary advances in engineering and computing are applied to patient care.

The ability to collect and analyze large complex data sets is one of the keys to understanding global health trends, the effectiveness of treatments across populations, and finding new vulnerabilities in the DNA of known diseases. Blue Waters, one of the most powerful supercomputers on a college campus, has already made breakthroughs in science and medicine, including modeling the structure of the HIV capsid, which will lead to new antiretroviral drugs.

This new College of Medicine is a partnership between the University of Illinois and Carle Health System. Carle is the leading hospital in east central Illinois and is recognized nationally for critical, stroke, pulmonary, and gastrointestinal care. The partnership with Carle will give students and faculty access to a full-scale integrated healthcare system that will allow them to develop new knowledge and draw on the knowledge and experience of the Carle physicians.
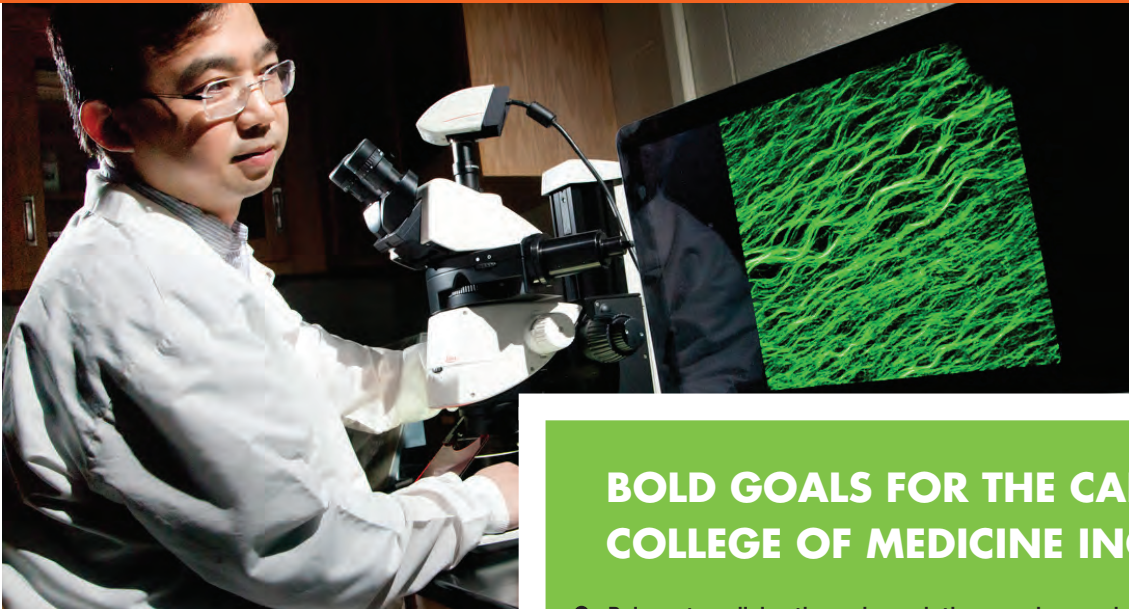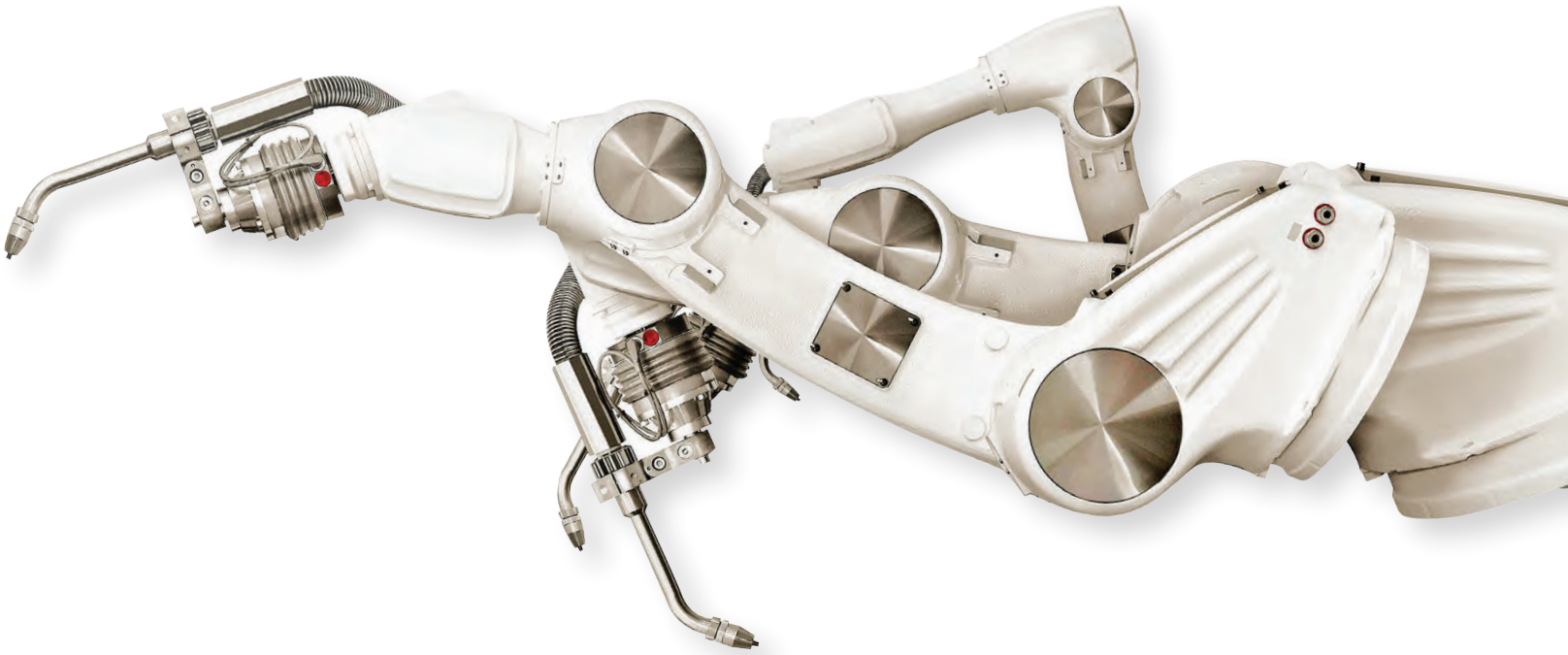
The impact of the College of Medicine will be realized on campus through the recruitment of leading faculty and physicians and leveraging their revolutionary advances to further biomedical research and medical education; in the Urbana-Champaign community in supporting translation, startup activity, and commercialization; and it will strengthen the State's competitive position and drive positive economic development including new jobs across the state.

Plans are under way for the first class of approximately 25 students to start by fall 2018. These trailblazers will launch a new paradigm in medicine that will provide benefits to society for future generations.

BOLD GOALS FOR THE CARLE ILLINOIS COLLEGE OF MEDICINE INCLUDE:

- Reinvent medicine through revolutionary advances in engineering and technology to improve patient outcomes, while lowering costs and increasing global accessibility to care.

- Educate a new generation of physician-engineers and physician-inventors who will accelerate the medical application of cutting-edge technology to improve outcomes throughout the continuum of care.

Learn more about the new College of Medicine at http://www.medicine.illinois.edu/.

Illinois Funded by Google on Innovative Mobile-First, Open Web of Things Initiatives

Professor Robin Kravets

CS @ ILLINOIS researchers have been **funded by Google** on two new initiatives. Through **Mobile-First,** funded by a $1 million Google Focused Research grant, Illinois will not only advance innovative research, but also a compelling undergraduate curriculum for mobile and cloud computing. Additionally, Illinois is joining a cohort of national research universities funded by Google to enable effective use and broad adoption of the **Internet of Things** (IoT).

> " We believe the collaboration with and across universities will accelerate innovation "

Mobile-First Research and Undergraduate Course Development

Funded over a three-year period, Mobile-First is supporting the research of CS Professor Robin Kravets into heterogeneous mobile computing and distributed systems. Her work will focus on coordinated cross-device power management, as well as efficient collaborative communication for crowded bandwidth-constrained environments (like concerts or sporting events).

Mobile-First's education component—spearheaded by CS Professors Craig Zilles and Indranil Gupta, plus CS Lecturer

Lawrence Angrave—will enable CS @ ILLINOIS to integrate Android as the primary mobile platform for three large critical required courses targeted at freshmen and sophomores, including a new freshman-level software engineering course. Google's support will also impact advanced CS courses, which will have access to Google's Cloud Platform, providing students real-world experience working with remote-cloud environments. Other key collaborators include CS Department Head and Abel Bliss Professor Rob A. Rutenbar and Sohaib and Sara

Abbasi Professor of Computer Science Roy H. Campbell.

"CS @ ILLINOIS is the home of the first and largest Android MOOC, with 140,000 learners worldwide," said Rutenbar. "Our College of Engineering educates more engineering undergraduates than MIT, Stanford, and CMU combined. We understand education at scale, and Mobile-First will provide a significant boost as we teach the next generation of mobile programmers."

Bringing Open Technology to the Internet of Things

CS @ ILLINOIS is also setting off on a Google-funded Expedition to bring the next generation of mobile technology and an open IoT to the everyday user. By enabling and simplifying communication between a user's mobile devices and embedded devices in the user's everyday spaces—both public and private—researchers hope to create a seamless experience that engages users with their nearby environments.

Illinois is joining a cohort of national research universities funded by Google on the Open Web of Things Expedition. CS researchers, led by Kravets, will collaborate with researchers from Carnegie Mellon University, Cornell Tech, Stanford, and Google to design open IoT technology that can be freely shared and enhanced. Chosen for their expertise in mobile computing and wireless communications, systems, and networking, Kravets and her colleagues will contribute vital functionality for managing proximity and for scaling to large IoT deployments.

"We funded the Open Web of Things Expedition to encourage universities to explore various aspects of system design that could help enable the Internet of Things," said Maggie Johnson, Director of University Relations at Google. "We believe the collaboration with and across universities will accelerate innovation and IoT adoption." These universities "were selected to join based on their unique approaches for tackling critical challenges related to privacy and security, systems and protocols, and HCI."

As the birthplace of the Mosaic Web browser, which paved the way to the explosive growth and impact of the Internet, Illinois is uniquely qualified to also lead in the development of IoT and enable IoT to achieve its full potential. Through the collaboration in the Open Web of Things Expedition, the dream of IoT is closer to becoming a reality.

Over the past several years, wireless technology has become commonplace. By 2019, IoT-enabled devices are expected to reach a deployment of 60 million. This large deployment, particularly of devices that have lower energy costs, is what researchers anticipate will enable IoT to breakthrough from the research lab to the real world. However, the number of devices being launched in the near future will bring new challenges.

Because an IoT ecosystem is a complex combination of devices with divergent capabilities and connectivity potentials, there is no one-size-fits-all solution to managing limited resources, such as bandwidth and energy. Researchers from Illinois will seek to address this by balancing a user's access to IoT data with the energy consumption of the user's device. Ultimately, a user would receive more relevant data for less energy consumption.

"It's going to be fascinating to see the research contributions that come out of both the Expedition and Mobile-First. We anticipate innovations in cross-device power management and coordinated mobile-to-mobile communication that will support and enhance the experiences of users who are increasingly carrying more devices with more capabilities," said Kravets, discussing her participation and leadership in both initiatives.

Sinha Receives $1 Million NIH Grant to Model Gene Regulation

BY TOM MOONE

Anyone who has been to a symphony knows that the beauty of the music depends on each player and section of the orchestra starting at the proper time, and then ending at the proper time. Only when everything occurs in the proper order and in sync does the musical piece make its statement.

All of this would be quite difficult without the work of the conductor who coordinates the piece, and signals musicians when to begin and when to stop.

For CS Professor Saurabh Sinha, the development of life works much the same. As an organism develops, the genes found within the DNA begin turning on and off in a particular order to have the organism develop in a particular way. "There's a very precise coordination of the timing and the location of genes turning on and off, like a massive symphony that's coordinated with exquisite detail," he said. "It's been an open question how this orchestration of thousands of genes happens in a precise way, and in the same way from one organism to another."

To help answer this open question, Sinha recently received a $1 million grant from the National Institutes of Health to begin a four-year project titled "Quantitative Modeling of Sequence-to-Expression Relationship." The focus of the project will be gene regulation—understanding how genes are turned on or off in a particular cell at specific times as an organism develops. "That process of development is a huge mystery," said Sinha. "We have a rather poor understanding of how that same DNA in one cell can give birth to all the kinds of cells we have in our bodies. One cell with one copy of DNA from each parent is

In a sense, Sinha is interested in uncovering the conductor in the symphony of life. What is the process that oversees and coordinates the implementation of particular genes at specific times?

DNA is made up of a series of nucleobases: adenine (A), cytosine (C), guanine (G), and thymine (T). With just these four bases set in a particular sequence with DNA, an individual organism is able to develop fully from a single cell. As Sinha explained, "We know the alphabet [of DNA], which is A, C, G, and T, but a lot of complex stuff is written with this alphabet, and we do not know that language."

Some parts of DNA are understood: the genes. Studies of the genomes have helped map out these portions of the DNA. So it is understood that particular parts of DNA (the genes) have impact on certain areas of development, but "the rest of the DNA, which comprises a whopping ninety-eight percent of the human DNA, is not genes," said Sinha. "In fact, a lot of it is dedicated to controlling the activity of genes."

In a sense, Sinha is interested in uncovering the conductor in the symphony of life. What is the process that oversees and coordinates the implementation of particular genes at specific times?

Professor Saurabh Sinha

And how that 98% of the DNA controls the other 2% remains a mystery—a mystery that Sinha will explore. He hopes to reveal the actions of the conductor of this symphony of gene regulation.

Sinha's project will use computational algorithms to model the available data on DNA. The data for this project come from genetic information on fruit flies provided in part by Professor Stas Shvartsman, Sinha's collaborator at Princeton University. Analysis of these data will lead Sinha to be able to model how changes to a particular genomic sequence may affect the gene regulation process.

Sinha explained: "We use methods that are based on biophysical principles. Principles of how different molecules interact with each other. We encode those ideas into algorithms that can run fast and process large amounts of sequences. Then we use these tools to see if they can explain experimentally collected data."

After developing the models, Sinha will better be able to predict what effect a mutation—even the smallest mutations—may have on an organism's development. "Our model could be able to predict the effects of even a single nucleotide mutation," he said.

The knowledge that can be gained from research like that being undertaken by Sinha could lead to the development of precision medicine. There are many instances in which different medications for a similar disorder will affect patients differently. Precision medicine would enable doctors to examine a patient's genome and determine more accurately which particular regimen would be the most beneficial for a particular patient.

Though the potential health benefits are exciting, and though these are the basis for the NIH funding his project, Sinha is just as excited about the basic science questions that his research could answer. "To me what's equally important—as important as the health applications in precision medicine—is the promise of these methods to answer fundamental, unsolved problems of biology," he said. "The question of how an organism develops—people have been going at that for a hundred years now."

Xie's Collaboration on Pex Benefits Microsoft and CS Education

BY TOM MOONE

Since the mid-2000s, CS Professor Tao Xie has been working with Microsoft Research to develop more effective software testing methods, helping the company improve the utility and impact of its software development tools. At the same time, Microsoft Research has facilitated the development of educational resources for use in teaching computer science. Xie's collaboration is an excellent example of how interactions between industry and academia can provide benefits to both spheres.

Professor Tao Xie

Developing Pex

Xie's relationship with Microsoft Research started in 2005, when he was a PhD student at the University of Washington examining ways to improve automated software testing. In fact, Wolfram Schulte, a researcher at Microsoft Research, served as a member of his thesis committee.

Because of these connections and his research interest, Xie was invited to consult with Microsoft Research on a new project: Pex (Program Exploration) in 2007. He subsequently spent several summers at Microsoft Research as a consulting researcher on the project.

The technique that underlies Pex is dynamic symbolic execution. In dynamic symbolic execution, potential paths of a given program are systematically explored by generating test data. Yet, for object-oriented software, the search space can be huge, making automated testing difficult. Xie developed a key algorithm, called Fitnex, to guide path exploration. "The algorithm I helped design and implement allowed us to cover more portions of the code and have a higher chance of finding bugs in the software program," Xie said.

Xie's partnership has provided benefits to Microsoft Research, but he also believes that he gained insights applicable to his university job. For Xie, an important benefit was that he was able to closely interact with his Microsoft collaborators and see what their interests and challenges were. "We could leverage the very powerful infrastructures developed by industrial labs, particularly the Pex infrastructure," Xie said. "My students could come up with innovative ideas for improving the infrastructure to deal with various complicated situations in the real world software programs." Such industry-academia collaborations have enabled the university research to focus on the most relevant and important problems in practice, and to develop innovative solutions that can be feasibly and efficiently built, thanks to the powerful infrastructure developed by the industrial labs.

CODE HUNT

Visual Studio 2015

In July 2015, Microsoft released Visual Studio 2015, the latest version of one of the most widely-used software development environments today. Contained in that release is the IntelliTest unit testing tool, which is, essentially, Pex. The tool's inclusion in Visual Studio brings automatic test generation to average software engineers, alleviating time-consuming manual test data generation.

"It has been a wonderful journey of collaborating with Microsoft Research on Pex," Xie said. "In the future, besides continuing our collaboration on Pex and Code Hunt, we are expanding the collaboration scope, recently working with the Software Analytics group at Microsoft Research, to continue producing high impact in the software industry."

Pex for Fun & Code Hunt

Pex for Fun was started by Nikolai Tillmann and Peli de Halleux, Xie's collaborators from the Pex team at Microsoft Research, who wanted a way for participants of Pex-training workshops to experience features of Pex without needing to download the entire software package.

At its launch in 2010, the interactive website was quite basic. "Although the name of the website is Pex for Fun, it was not a whole lot of fun," Xie said. "You would type in code, and get the testing results. People may not come back to try the website again and again."

Xie suggested developing something that could be used as a teaching tool, and that could incorporate more fun elements. It was his idea to introduce Coding Duels: interactive puzzle games where the user has to create code with the same behavior as another, hidden method. Since its release, players have made close to 1.7 million game interactions in Pex for Fun.

After Pex for Fun had proven to be a popular tool, Judith Bishop, Director of Computer Science in Microsoft Research Outreach, joined the Pex team to design a site especially for use by students and educators that would be even more appealing. That was the genesis of Code Hunt, which was launched in 2014. Designed to be effective in running coding contests, Code Hunt adds a friendly interface, an interactive tutorial, hint generation, and the ability to work with Java, a popular language for introductory computer science courses.

Code Hunt provides a learning experience targeted at educators and students.

From left: Professor Saurabh Sinha and Gene Robinson

Genomics Among the Biggest of Big Data, Experts Say

BY LIZ AHLBERG, U OF I NEWS BUREAU

Each cell in the body contains a whole genome, yet the data packed into a few DNA molecules could fill a hard drive. As more people have their DNA sequenced, that data will require massive computational and storage capabilities beyond anything previously anticipated, says a new assessment from computational biologists and computer scientists at the University of Illinois and Cold Spring Harbor Laboratory.

The team of experts compared data needs of genomics with three of the biggest players in big data: astronomy, Twitter, and YouTube. They projected growth in each area through the year 2025 and found that genomics is poised to be a leader in data acquisition, storage, distribution and analysis.

The team's assessment is published in the journal *PLOS Biology*.

"As genome-sequencing technologies improve and costs drop, we are expecting an explosion of genome sequencing that will cause a huge flood of data," said Gene Robinson, a professor of entomology and the director

"If genomics is to realize the promise of having a **transformative positive impact** on medicine, agriculture, energy production and our understanding of life itself, **there must be dramatic innovations in computing. Now is the time to start.**"

of the Carl R. Woese Institute for Genomic Biology at the U. of I. "The only way to handle this data deluge will be to improve the computing infrastructure for genomics.

"Astronomy, Twitter, and YouTube represent three diverse domains that generate and use a huge amount of data, albeit with huge differences in computing needs. The diversity of these three forms of Big Data provides an excellent framework for comparative analyses with genomics," he said.

Like YouTube and Twitter, genomics data are highly distributed, coming from many different sources. However, both Twitter and YouTube have standard formats for their entries, while genomic data can assume many different formats, making sharing and storing more complex.

The authors estimate that the genomics information so far, from sequencing different organisms and a number of humans, has produced data on the petabyte scale (a petabyte is a million gigabytes). However, over the last decade, genomic sequencing data doubled about every seven months, and will grow at an even faster rate as personal genome sequencing becomes more widespread. The researchers estimate that by 2025, genomics data will explode to the exabyte scale—billions of gigabytes. This surpasses even YouTube, the current title holder among the domains studied for most data stored.

Yet the sequences are only one element of genomic data.

"The DNA sequence in itself is not particularly useful for realizing all the great possibilities that genomics technology promises," said co-author and CS Professor Saurabh Sinha. "The sequence data have to be analyzed through

sophisticated and often computationally intensive algorithms, which find patterns in the data and make connections between those data and various other types of biological information, before they can lead to biologically or clinically important insights. All of this makes the goal much more challenging than just sequencing DNA and storing that information."

The need for complex analysis is similar to astronomy, but with an important difference, the authors say. Astronomy generates vast amounts of data but incorporates several processing technologies at the time of data collection, requiring less time and computational power later on. The researchers suggest that integrating similar processing methods could cut down on the storage needs for genomic data as well. But there's a catch: The whole genome may offer insights not yet anticipated, as new understandings may emerge as more people are sequenced.

"In the future, we may have to take the hard decision of storing only the processed form and not the original, and that, too, in heavily compressed forms, to drastically reduce the storage needs," Sinha said.

The authors urge new technology development to handle the expected explosive growth in genomics data beyond what is predicted for social media and astronomy.

"Genomics will soon pose some of the most severe computational challenges that we have ever experienced," Robinson said. "If genomics is to realize the promise of having a transformative positive impact on medicine, agriculture, energy production and our understanding of life itself, there must be dramatic innovations in computing. Now is the time to start."

Read the abstract of the study at the PLOS site: http://bit.ly/1gK6XSN.
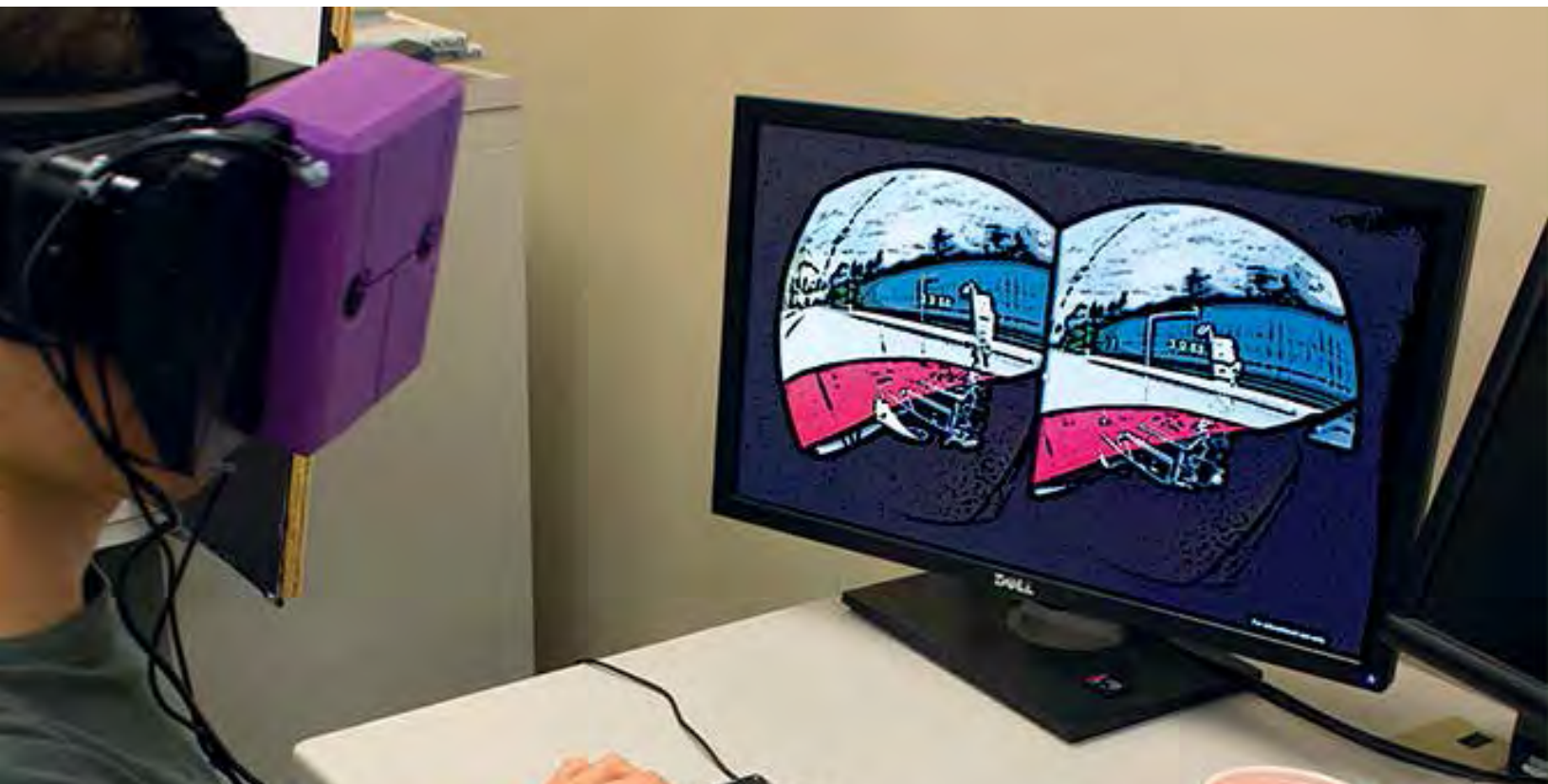
Grad Student's Research Aims to Enhance VR Gaming Experience

BY LAURA SCHMITT

Wearing an Oculus Rift virtual reality (VR) headset, you're immersed in a chaotic pre-historic landscape, playing the role of a recent dinosaur hatchling attempting to complete four tasks. It's an incredible sensation to dodge an attacking dragonfly and have an up close encounter with a roaring adult T. Rex.

Amidst all this excitement, real-world reality is calling. You're thirsty and you'd like to grab a drink. But how can you do that without flipping the goggles off and interrupting the gaming experience? CS graduate student Pulkit Budhiraja thinks he has a solution.

For his master's thesis, Budhiraja designed several mixed reality renderings that selectively incorporate the physical world into the virtual world for interactions with physical objects. He then conducted a user study to compare his techniques, which balance immersion in a virtual world with ease of interaction with the physical world.

"It is a genuine usability issue because you become completely blind to the world when you're wearing the display," said Budhiraja, who is conducting research in CS Professor David Forsyth's group. "We wanted a solution that doesn't hamper the sense of immersion you have in a virtual world."

Budhiraja's solution included attaching two cameras to an Oculus Rift, creating a stereo view of objects in front of the user. "The cameras are your proxy eyes," said Budhiraja, who wrote a color segmentation algorithm to selectively feed content into the virtual world scenario. "We chose to show all the colors in the skin color range, so users could see their hands. We also color segmented for the color of the cup [in our experiment] so that, too, would be visible."

In addition, he added the edges of other objects like the keyboard and desk to give the user some context of where the drink was located. This approach, which he called Objects-Hands & Context (OHC), was the preferred method among 10 gamers who tried all four visual rendering methods he and his team developed.

According to Budhiraja, OHC allowed gamers to quickly re-acclimate themselves to the physical environment, especially when they were moving their head and body a lot as part of the VR experience.

While his color rendering technique was fairly simple, Budhiraja may pursue more sophisticated methods that could be applied to other objects of any color or size. For example, he could develop a system where a user shows a mouse or joystick to the external cameras from many angles, training the computer to recognize the physical object as something the user wants to interact with while immersed in the VR scene.

Budhiraja published the results of his project on arXiv, the electronic pre-print website for CS papers. *Discover Magazine* and *MIT Technology Review* picked up on the story. He is continuing to explore the boundaries between physical and virtual realities as part of his doctoral degree research at Illinois.

Pulkit Budhiraja

"We wanted a solution that doesn't hamper the sense of immersion you have in a virtual world."
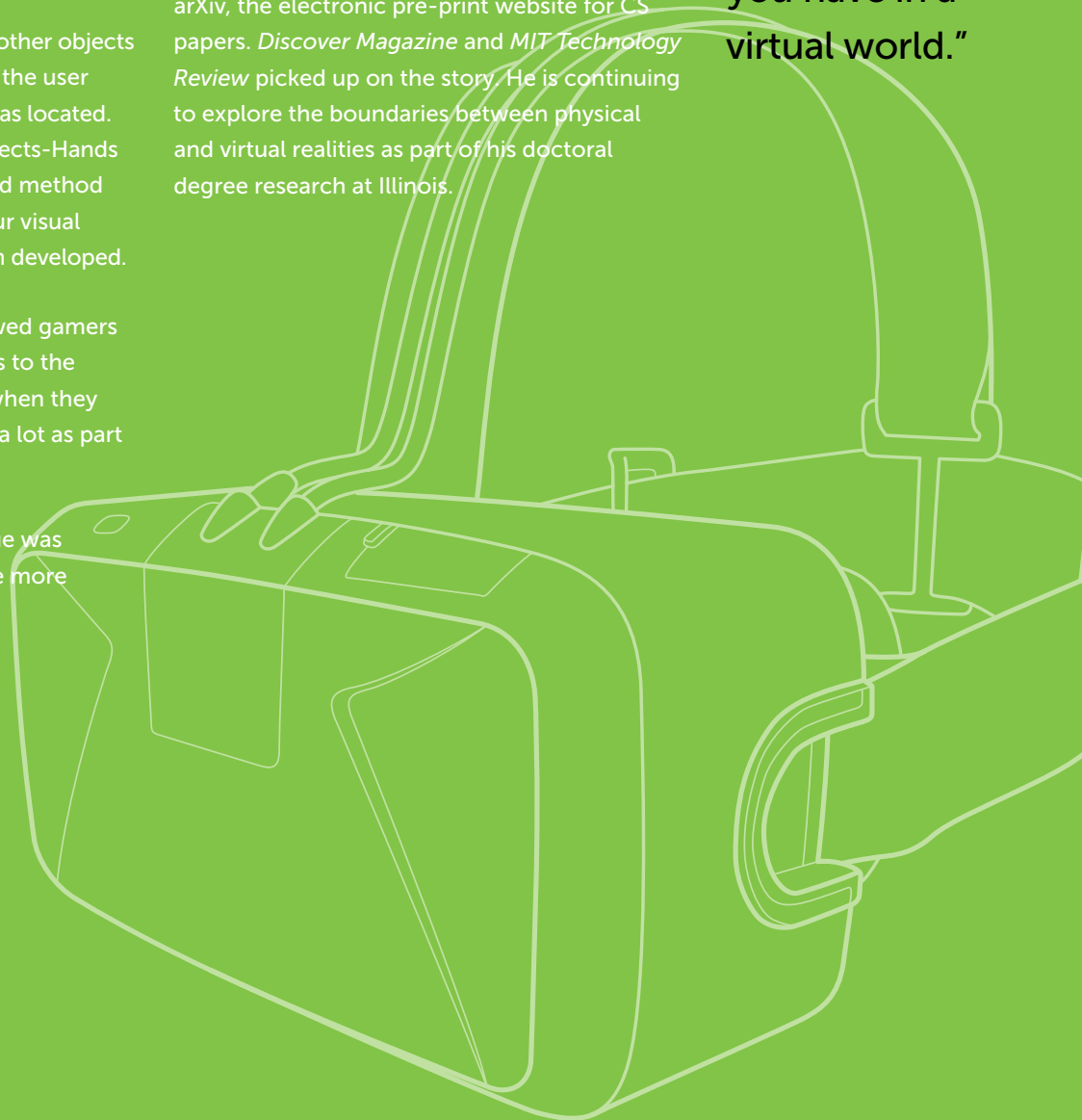
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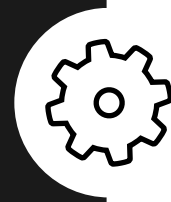
BY TOM MOONE

For the second year, the spring brought nearly a thousand students from across the country to Urbana-Champaign to work long hours to create innovative technology. And to have fun.

HackIllinois 2015, held February 27-March 1, built on the success of last year's inaugural event by taking what worked—which was, frankly, almost everything—and looking to see where they could make a good thing even better.

"We wanted to maintain the quality of our event," said CS senior Nathan Handler (BS CS '15), who co-directed the event with CS sophomore Nick Kortendick. "We knew we could grow, but we didn't want to overdo it."

One improvement was to turn the final project presentations into a showcase open to the entire community. The teams convened at the Illini Union on Sunday, March 1, for an early afternoon expo. The first two hours were similar to Engineering Open House, with members of the public interacting with teams and seeing what they had accomplished over the brief weekend. The diverse set of projects included a process for tracking where farm tractors

were located, real-time virtual reality chatting, and Quadcopter drones designed to help first responders during natural disasters. Winners were announced at a program during the final hour of the event.

Because participants at last year's inaugural HackIllinois had such a positive experience—and told their friends—this year's event had increased popularity and attendance. With the expectation of nearly a thousand attendees this year, the new ECE Building joined Siebel Center as an event venue. "Having this new building available is what really allowed us to grow the event," said Handler.

Last year's event included primarily schools from nearby states in the Midwest. In this second year, the geographic spread was a bit larger—participants came from schools as far away as the University of Waterloo and Georgia Tech University.

There were several activities to help people take a break from intense, concentrated coding. Participants had an opportunity to tour the Blue Waters petascale computing facility. In addition, last year's popular Nerf wars returned, as well

> **There were so many new and useful tools and apps made that meshed together technologies in ways that were brilliant.**
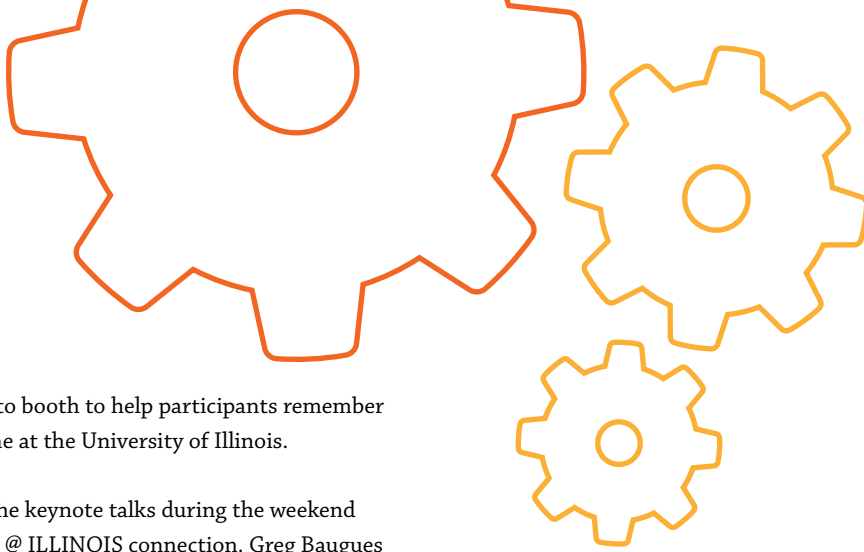
as a photo booth to help participants remember their time at the University of Illinois.

One of the keynote talks during the weekend had a CS @ ILLINOIS connection. Greg Baugues (attended through 2002), currently a developer evangelist at Twilio, gave a talk titled "Developers and Depression." HackIllinois organizers had seen Baugues speak at the department earlier in the year, and wanted him to bring this important message to the HackIllinois audience.

By the end of the weekend, some 180 projects were developed and presented to the public. Prizes were given to the top three hardware hacks and the top three software hacks. In addition, sponsoring companies gave out prizes for the use of their products or software. In all, 47 teams took home a prize for their efforts.

An event like HackIllinois, of course, relies on its volunteers to ensure a successful event. Fifty core volunteers had been working since the beginning of the school year to get the event off the ground and to prepare the logistics for the event. Over 200 additional volunteers helped out during the event weekend.

"We couldn't make it without the volunteers," said Handler. "We laid the groundwork, but they are the ones who really help us pull off a world-class event."

See a video on this year's HackIllinois: http://bit.ly/1Mq4AON.

See descriptions of this year's HackIllinois projects: http://bit.ly/1gY8ipi

Translating Code into Language Learning— and Cozad Victory

BY TOM MOONE

FlipWord, a language learning app created by Thomas Reese (MS CS '15), was the winner of the 2015 Cozad New Venture Competition in the non-university-funded projects category.

Reese has long had an interest in languages. As an undergraduate, he studied abroad in Hong Kong. Not surprisingly, he developed an interest in learning Chinese, and in less than two years, he became fluent. That experience instilled a passion for improving the language learning experience.

In 2014, Reese prototyped and demonstrated a new piece of language learning software at the inaugural HackIllinois. This initial, primitive version of FlipWord won the Most Technically Challenging prize. "That was the start of everything," Reese said.

Reese started attending hackathons regularly to provide concentrated time when he could work on modules of his language learning tool. And his work began paying off. Reese and his teammates started regularly winning prizes. Each hackathon project was under a different name and each covered a different aspect of his vision, but each was aimed at his goal of a revolutionary language learning software product.

Finally, this year's Cozad New Venture Competition, which encourages students to create new businesses, provided Reese an opportunity to present his final product. Hosted by the Technology Entrepreneur Center, this year's competition comprised 100 teams that were trimmed down over the course of the spring semester to six finalists. In April, the top projects presented a pitch to a panel of university and industry judges, including Marcin Kleczynski (BS CS '12) and Mark Tebbe (BS CS '83).

Because he had honed his project and presentation skills through a number of hackathons, Reese was confident he would do well in his final pitch. Nevertheless, winning was an exciting moment.

The prizes Reese received for winning the non-university funded category included creative services from Adjacency, legal advice and assistance from Singleton Law Firm in Champaign, office space in the University Research Park, and $15,000 to help start the business.

"This was something I was already motivated to work on," Reese said. "The Cozad Competition made me think about things I wouldn't have otherwise."

Reese is now working with CS undergraduate Joseph Milla (one of his hackathon partners) to finalize FlipWord for launch. He expects that the product will be available soon.

"I'm super excited about language learning," Reese said, "and I'm working on creating a startup to turn this into something useful to a lot of people."

At MadHacks, Reese and his teammates won the Wisconsin Idea Prize for their project UpTalk. From left: Anil Jason, Joseph Milla, Oreoluwa Alebiosu, and Thomas Reese.

You can try FlipWord for yourself at getflipword.com

Khurshid Runner-Up for Illinois Innovation Prize

BY COLIN ROBERTSON

Computer science PhD student Ahmed Khurshid was recognized as the runner-up for the Illinois Innovation Prize, which was presented by the College of Engineering's Technology Entrepreneur Center at the campuswide Entrepreneurship Forum on April 24. The award recognizes a student "who stands out as a passionate innovator and entrepreneur, who is working with world changing technology and is seen as a role model for others."

During the award ceremony, Andreas C. Cangellaris, Dean of the College of Engineering, announced that the $20,000 prize would be divided among the three finalists, since the students were each outstanding. Ritu Raman, a PhD candidate in Mechanical Science and Engineering, was announced as the 2015 winner and awarded with $15,000 for her work on developing and commercializing 3D printing technologies for applications in biomedical engineering. Amy Doroff, a senior in Industrial and Enterprise Systems Engineering, was awarded $1,500 as the third place finisher for a new process for installing lock collars on combines, developed during her summer internship at John Deere.

Khurshid, who is advised by CS Professor Matthew Caesar, received $3,500 for his research into networked computer systems, where he aims to bring provable security and correctness guarantees to critical infrastructure. "Being recognized as one of the three finalists for the Illinois Innovation Prize is a great honor for me," said Kurshid. "I am very happy to be part of a university that so actively encourages innovation and entrepreneurship through this and other initiatives. Competitions like this one make students think out of the box in their research and work hard to make a useful impact in solving challenging issues."

He is developing tools to validate routing and security properties of a network using a black-box analysis of network behavior, detecting and reacting to vulnerabilities and errors in real-time. This breakthrough in real-time analysis is possible thanks to the development of novel algorithms by Khurshid and his collaborators that are 100 to 1,000 times faster than conventional formal network analysis methods. In fact, his paper on real-time network property verification received the best paper award at HotSDN 2012, and his other papers have appeared in top computer networking conferences.

Khurshid has been working to commercialize his tools since 2013, when he co-founded Veriflow Systems, Inc. with CS Professors Matthew Caesar and Brighten Godfrey. Last year, the company, which is headquartered in the university's Research Park, successfully competed for an NSF Phase II Small Business Innovation Research (SBIR) grant.

A Fulbright Fellow from Bangladesh, Khurshid plans to start full-time at Veriflow Systems following his graduation, continuing his research on network verification.

About the Illinois Innovation Prize

The Illinois Innovation Prize, administered by the Technology Entrepreneur Center in the College of Engineering, is awarded on an annual basis to the most innovative student on campus. The recipient is typically a passionate innovator, working with world-changing technology, entrepreneurially minded, and a role model for others.

CS @ ILLINOIS Welcomes Three New Faculty

SANMI Koyejo

After receiving his PhD in 2013 from the University of Texas at Austin, Sanmi Koyejo joined the Poldrack Lab at Stanford University as postdoctoral engineering research associate. He will join CS @ ILLINOIS starting in fall 2016.

Koyejo is interested in the development and analysis of statistical machine learning techniques that trade off parsimony, scalability, and performance. His research is applied to various modern big data problems—including the analysis of large scale neuroimaging and genetics data—to address pressing clinical and academic research questions. He is currently developing new tools for mapping human brain networks and their association to behavioral and genetic factors.

Koyejo has been the recipient of several awards, including an outstanding undergraduate student award, a best student paper award from the Conference on Uncertainty in Artificial Intelligence (UAI), and a trainee award from the Organization for Human Brain Mapping (OHBM).

RUTA Mehta

Ruta Mehta's research lies at the intersection of theoretical computer science, game theory, and mathematical economics.

In addition to understanding the computability of equilibria, for both market and Nash, and the impact of strategic behavior in multiagent situation, her research is aimed at understanding applications of game theory to evolution, dynamical systems and learning.

In particular, Mehta's research has brought game theoretic ideas and dynamical system analysis to bear in order to understand the age-old question of genetic evolution under sexual reproduction. She has also explored the fundamental question of efficiently learning economic parameters through observed data.

Prior to her postdoctoral fellowship at Georgia Tech and her participation in the Simons Institute's Economics and Computation Program, she completed her PhD at the Indian Institute of Technology, Bombay, under the guidance of Prof. Milind Sohoni. Her thesis was recognized with the 2012 ACM India Doctoral Dissertation Award. In 2014, she was conferred the Best Postdoctoral Research Award by the College of Computing at Georgia Tech. She will start at Illinois in spring 2016.

SASA Misailovic

Sasa Misailovic obtained his PhD from MIT in 2015. His research interests span programming languages, software engineering, and computer systems, with an emphasis on investigating approximate computing techniques that can improve performance, energy efficiency, and resilience of programs.

Misailovic's doctoral research presents the foundation of a new approach to program optimization: systems that automatically generate approximate versions of programs, successfully trading accuracy of a program's results for faster and more energy-efficient execution. These optimization systems target emerging application domains, such as multimedia processing, machine learning, and big data analytics, which operate on noisy inputs or which solve problems that have multiple acceptably accurate solutions.

His research has received two best paper awards at leading programming languages conferences (OOPSLA 2013 and OOPSLA 2014). His work was also recognized with an invited article in the Communications of the ACM.

As part of his ongoing research, Misailovic is investigating how to redesign programming languages and compilers to help developers efficiently construct fast, resilient, and self-adaptive software. He is scheduled to join the department in fall 2016.

Adve Elected to CRA Board of Directors for a Third Time

CS Professor Sarita Adve was recently elected by her peers to the Computing Research Association (CRA) Board of Directors for a third term. The limit is nine years of continuous service, so this will be her final term on the board.

Formed in 1972, the CRA seeks to strengthen research and advanced education in computing and allied fields. It counts among its members more than 200 North American academic departments of computer science, computer engineering, and related fields; laboratories and centers in industry, government, and academia engaging in basic computing research; and affiliated professional societies.

Adve's leadership and contributions to the field include co-developing memory consistency models for the Java and C++ programming languages, which are based on her PhD thesis work on data-race-free memory models. Other significant contributions include the concepts of lifetime reliability aware architecture and dynamic reliability management, work on cross-layer energy management, exploiting instruction-level parallelism for memory system performance, and multiprocessor simulation methods.

Adve was named a Woman of Vision in Innovation by the Anita Borg Institute for Women in Technology in 2012. A Fellow of the IEEE and ACM, she received the ACM SIGARCH Maurice Wilkes award in 2008, was named a University of Illinois University Scholar in 2004, and received an Alfred P. Sloan Research Fellowship in 1998.

Warnow Invested as a Founder Professor

BY TOM MOONE

Earlier this year, CS and Bioengineering Professor Tandy Warnow was invested as a Founder Professor of Engineering. She is an expert in the application of mathematics and computer science to developing algorithms for complex problems in the fields of phylogenomics (the intersection of evolution and genomics) and metagenomics (the study of genetic material in the environment). Warnow joined the University of Illinois in 2014. Prior to that she had been the David Bruton Jr. Centennial Professor in Computer Science at the University of Texas at Austin, where she had taught since 1999. She was on the faculty at the University of Pennsylvania from 1993 to 1999.

> We are all of us so lucky to be here. We have work we love to do. We get to try to inspire our students to have the same faith in themselves, to love something, and to keep doing the thing they love.

Her work was recently featured in a series of articles in *Science* on the Avian Phylogenetics Project. This project used the genomic sequences of 48 bird species to develop a new understanding of the evolutionary family tree of birds.

Warnow's work has also been applied to historical linguistics, developing and using statistical models to capture the evolution of languages and to develop and implement statistically based and combinatorial methods to reconstruct language phylogenies. In her remarks at the investiture, Warnow told the audience, "We are all of us so lucky to be here. We have work we love to do. We get to try to inspire our students to have the same faith in themselves, to love something, and to keep doing the thing they love."

Warnow received an NSF National Young Investigator Award in 1994, a David and Lucile Packard Foundation Fellowship in 1996, a Radcliffe Institute for Advance Study Fellowship in 2003, and a John Simon Guggenheim Foundation Fellowship in 2011. Warnow served as the chair of the NIH study section on Biological Data Management and Analysis (BDMA) from 2010 to 2012.

The Founder Professorships in Engineering are made possible by the Grainger Engineering Breakthroughs Initiative, the result of a $100 million investment in the College of Engineering. The Founder Professorships commemorate Stillman Williams Robinson, the first faculty member to teach engineering at the University of Illinois and the first dean when the College of Engineering was organized in 1878.

Padua Receives IEEE Computer Society's Goode Award

BY TOM MOONE
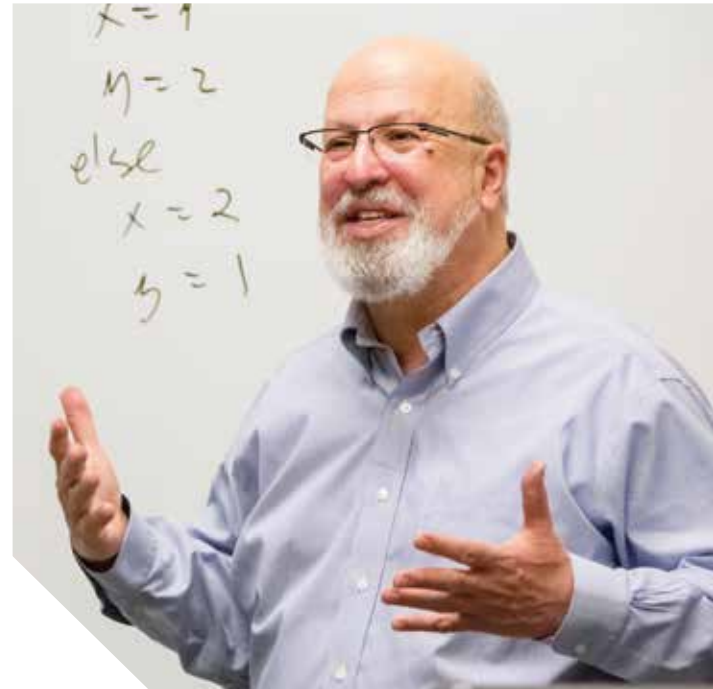
CS Professor David Padua has been named the recipient of the 2015 IEEE Computer Society Harry H. Goode Award. The Goode Award was established to recognize achievement in the information-processing field–either a single contribution of theory, design, or technique of outstanding significance; or the accumulation of important contributions on theory or practice over an extended period. Padua was cited "for basic and lasting contributions to parallel languages, compilers, and tools."

"I am honored to be selected for this award, grateful to those who nominated me, and thankful to the IEEE Computer Society with which I have been associated for many years," said Padua.

Padua, a Donald Biggar Willett Professor of Engineering, focuses his research on program analysis, transformation, and optimization strategies. The main objective is to develop methodologies to facilitate the programmer's task of creating reliable, easy-to-maintain programs that achieve excellent performance. Ongoing projects include the study of program optimization strategies and the design of compiler techniques for new parallel programming constructs. In recent projects, Padua has worked on autotuning, high level notations for parallel programming, compiler evaluation, and the efficient implementation of scripting languages. A Fellow of the ACM and the IEEE, he was editor-in-chief of Springer-Verlag's *Encyclopedia of Parallel Computing*.

The Goode Award consists of a bronze medal and a $2,000 honorarium. Past recipients include luminaries like John Mauchly, Maurice Wilkes, Grace Murray Hopper, and Seymour Cray. IEEE Computer Society is the world's leading computing membership organization and the trusted information and career-development source for a global workforce of technology leaders including: professors, researchers, software engineers, IT professionals, employers, and students.

> "I am honored to be selected for this award, grateful to those who nominated me, and thankful to the IEEE Computer Society with which I have been associated for many years."

Professor Josep Torrellas

Torrellas Receives the IEEE Computer Society Technical Achievement Award

BY LAURA SCHMITT

CS Professor Josep Torrellas is one of four prominent technologists who recently received the 2015 IEEE Computer Society Technical Achievement Award. Torrellas was recognized for his pioneering contributions to shared-memory multiprocessor architectures and thread-level speculation.

During the last 15 years, Torrellas and his graduate students have made important research advances that help shared-memory multiprocessors work better. The contributions span the areas of cache coherence, memory consistency, thread-level speculation and synchronization. These advances make it easier to program these machines while enhancing their performance.

""It's nice to receive an award, but it's an award for the work done by many people, so I'd like to recognize my students," Torrellas said.

In addition, Torrellas' work has addressed energy efficiency issues in multiprocessor architectures. He has devised techniques to handle process variation and wear-out, dynamic voltage reduction, memory refresh optimization, multiple voltage domains, and 3-dimensional architectures. "We explored many techniques that work together to make many core more energy efficient," he said. "It's the work of many generations of students."

Today, Torrellas is conducting research to make the multicores in smart phones and tablets more programmable, energy efficient, and secure. In one NSF-funded project, Torrellas is investigating architectural support for scripting languages like JavaScript and Python on mobile devices. CS faculty Tao Xie, Darko Marinov, and Maria Garzaran, and University of Wisconsin Professor Nam Sung Kim are collaborating on this project with him.

In another project, Torrellas is developing aggressive low-voltage architectures for computers that range from laptops to high-end exascale machines. Ideally, he aims to increase the energy efficiency of 1000-core chips by 100x, while addressing issues like processor variation and slower operating speed. Working with Professors Nam Sung Kim (University of Wisconsin), Radu Teodorescu (MS CS '05, PhD '08; Ohio State University), and Ulya Karpuzcu (MS CS '09, PhD CE '12; University of Minnesota), Torrellas is developing techniques that cut across the technology, circuits, architecture, and run-time layers. This project is funded by Intel and the Departments of Energy and Defense.

IEEE computer society

Sinha and Xie Chosen as Willett Scholars

Saurabh Sinha and Tao Xie were among ten faculty in the College of Engineering selected as Donald Biggar Willett Scholars for 2015. This recognition is targeted for faculty members who, at a relatively early stage in their careers, are excelling in their contributions to the University of Illinois.

CS Professor Saurabh Sinha's research is concerned with computational approaches to problems in molecular biology, especially gene regulation in metazoan genomes. An affiliate member of the Carl R. Woese Institute for Genomic Biology, his work looks to understand how sequences involved in gene regulation have evolved, and how such evolutionary dynamics may inform the discovery of novel regulatory sequences. Sinha is a principal investigator at the Center of Excellence for Big Data Computing, an Illinois-Mayo Clinic joint project focusing on the rapidly growing body of genomic and transcriptomic data produced by genome-wide, high-throughput experimental technologies. An affiliate of the Department of Entomology and the Biophysics program, Sinha has also been recognized with the Dean's Award for Excellence in Research from the College of Engineering.

CS Professor Tao Xie joined the Illinois faculty in 2013. Before then, he was an associate professor in the Department of Computer Science at North Carolina State University. His research interests are in software engineering, with a focus on software testing, program analysis, and software analytics. Several of Xie's contributions to software analytics—where researchers use large existing collections of software and associated material to understand software practices—and to efficient test generation have been adopted by Microsoft Research. He currently leads the Automated Software Engineering Research Group at Illinois.

CS Professors Tarek Abdelzaher and ChengXiang Zhai are also current Donald Biggar Willett Scholars in the College of Engineering.

The Willett Research Initiatives in Engineering funds term professorships, undergraduate and graduate student research, and related research activity. It honors the memory of Donald Biggar Willett (1897-1981) who attended the University of Illinois from 1916-1921. Mr. Willett left the University before graduation, just a few credits short of completing his coursework in civil engineering. He started his career as a partner in the family business, Suburban Coal and Supply Company, and later, worked as a self-employed bookkeeper and tax preparer. In 1994, his widow, Elizabeth Marie Willett, willed her entire estate to the College of Engineering, which established the Willett Research Initiatives Fund.

Professor Saurabh Sinha

Professor Tao Xie

The Willett Research Initiatives in Engineering funds term professorships, undergraduate and graduate student research, and related research activity.

Rosu's Runtime Verification Approach Could Make Cars Safer

BY LAURA SCHMITT

Recently, white-hat hackers were able to remotely take control of a Jeep Cherokee SUV by exploiting an electronic opening through the vehicle's radio—ultimately disabling the SUV's brakes.

On July 24, Fiat Chrysler Automobiles recalled about 1.4 million of its vehicles, including the Cherokee, to update software that would fix the problem.

This incident illustrates the challenges facing the entire auto industry as it deals with costly recalls due to design flaws in complex software and vulnerabilities in Internet-connected WiFi and navigation systems.

According to CS Professor Grigore Rosu, an expert in developing techniques to verify software reliability, today's vehicles have anywhere from 20 to 70 little computers, known as electronic control units (ECUs), that execute millions of lines of software code. The ECUs, which run proprietary software developed by third-party vendors, communicate over a rudimentary electronic network—the CAN bus—to control the power windows, engine, doors, brakes, etc.

"What hackers could do is break into the system and impersonate an ECU to send messages on the bus," Rosu said. "For example, imagine if the code running the power window ECU, windshield ECU, or brake ECU is faulty, then it could send messages to accelerate your car, maliciously (caused by hackers) or not."

Rosu, whose software startup Runtime Verification Inc. makes products to verify software reliability, recently received a $150,000 National Science Foundation SBIR Phase I grant to address automotive software failures and security compromises. He is customizing a version of the company's RV-Monitor system to create a new ECU that oversees vehicle computer safety.

Collaborating with a major ECU developer, Grigore Rosu's group is creating a new ECU known as RV-ECU that will be connected to the CAN bus and can read/write messages on the bus like any other ECU, but it will be dedicated to car safety.

The proposed technology, known as RV-ECU, will enable automakers to configure, efficiently monitor, and enforce many safety and security policies at runtime both across networks of ECUs and on

Original source aa1car.com.

Professor Grigore Rosu

individual ECUs. It will allow ECU code developers and system architects to conveniently separate safety and security from functionality to advance and improve each independently.

Rosu's approach is unique because it works without having access to the ECU code—something conventional methods like static analysis require. His RV-ECU will take the carmaker's safety specs and automatically monitor in real time all the safety properties, making sure the car doesn't do anything it isn't supposed to do. "Our RV-ECU technology won't check the functional correctness of the ECU's code, but it will make sure they don't do bad things at runtime," Rosu said.

If vulnerabilities are found or safety improvements are desired, Rosu said, his technology may enable automakers to fix them through software downloads via the Internet—similar to how consumers automatically download software updates for their phones and computers.

"The automakers now have an incentive to architect their systems differently because it could save them millions if not billions from recalls," Rosu said. "They could issue a safety patch and [owners] could choose when to upgrade the car software."

ROSU's RV-ECU will take the carmaker's safety specs and automatically monitor in real time all the safety properties, making sure the car doesn't do anything it isn't supposed to do.

Bailey and Olson named Education Innovation Fellows

BY TOM MOONE

CS @ ILLINOIS is known for its commitment to innovation and discovery in computer science research. But, never far from this is the department's mission to prepare the next generation of computer scientists for careers in industry or for graduate school.

To support innovation in education, CS Professors Brian Bailey and Luke Olson have been selected to serve as Education Innovation Fellows (EIFs) in the College of Engineering's Academy for Excellence in Engineering Education (AE3). In this role, they will support the work of college faculty engaged in Strategic Instructional Innovations Program (SIIP) projects to develop innovative, collaborative new approaches to teaching engineering across courses or across departments.

As Bailey and Olson assist the SIIP projects, they expect to gain value from their participation. "A main benefit from my perspective is working to create better educational experiences for our students and equipping them with the right skill sets to be successful in the workplace," Bailey said.

Olson said, "It has really energized my view of teaching. "It's helped me explore a whole world of teaching techniques and directions that we're bringing back to the department."

EIFs also provide advice to the College of Engineering regarding policies and programs related to the college's teaching mission. They provide input to AE3 on its other programs, such as the Collins Scholars (a program for new engineering faculty) and its GATE program (a program to enhance instruction at the course level).

BRIAN BAILEY first became interested in EIF program when he saw an open call for participants. "The program was appealing because I wanted to participate in and become aware of the educational innovations happening throughout the College," he said. "Of particular interest is how instructors are managing growing enrollments in their undergraduate courses."

LUKE OLSON became involved with the EIF program after a long-standing relationship with AE3. He was first introduced to AE3 when he started at the University of Illinois, through their programs for new instructors. "I just stayed in touch with them [after that]," he said, "and have always been interested in classroom innovation." Olson gives a lot of credit to AE3, which sponsors the EIF program, the SIIP initiatives, and other programs geared to improving the educational experience in the College of Engineering: "They've done an amazing job connecting people from different departments and bringing innovations to a variety of courses across the college."

Virtual Reality Course Brings Students to the Forefront of Technology

BY TOM MOONE

Putting on the headset, you find yourself suddenly riding a platform that takes you twenty feet in the air as you try to keep your balance, or shooting at angry robots that are a menace to society, or becoming a frog trying to eat bugs before they get past you, or even paying a visit to the ancient Assyrian palace in Nimrud, Iraq. All of this in an immersive 3D environment—giving the experience a sense of reality not found in standard videos.

And all of these virtual reality worlds were created by University of Illinois students in CS 498SL: Virtual Reality. This course was taught in the spring 2015 semester by CS Professor Steven LaValle. In fall 2014, LaValle returned to Illinois after an extended leave of absence during which he served as principal scientist at Oculus, developer of the Oculus Rift virtual reality headset. Oculus was acquired by Facebook in 2014 for $2 billion.

The 100 students in the virtual reality (VR) course were taught the latest technology from someone who had helped develop it.

VR is not new. LaValle explained that the technology began in the 1960s, and there was a surge in research in it during the 1990s. But interest in VR waned because the cost of the necessary equipment was so high.

Products like the Oculus Rift have changed that. "In this current wave of technology, things have changed with a high level of quality in a low-cost portable headset," said LaValle. "Virtual reality causes a lot of hype and excitement, and now the barrier to entry matches that. Before, it was unattainable. You had to spend a million dollars on a system, and it still wasn't very compelling after that. Many headsets are appearing on the market now, and they are low cost and very compelling."

The VR course focused a lot on issues of human perception and comfort. One important issue is *vection,* the perception of motion when a person's body is actually stationary. "If you've ever been stuck in traffic before, and a truck starts moving and you might feel like you are moving backwards; that's an example of vection," said LaValle. "Your eyes have convinced you that you're moving backwards and it is sometimes uncomfortable."

Entering into a virtual world with goggles on, and seeing movement, the brain is receiving contrasting information. The eyes tell the brain that the body is in motion, but other parts of the body tell the brain that the body is stationary. Too much of this can cause discomfort or even motion sickness.

Virtual reality causes a lot of hype and excitement, and now the barrier to entry matches that.

"It is interesting how many small things can cause nauseousness," said Thomas Reese (MS CS '15), one of the students who took the course. "Professor LaValle taught us throughout the semester just how much the brain 'auto-corrects' our world. In order to cope, developers have to augment, reverse, and override many of our brain's perceptions [in order to] make VR a comfortable experience."

LaValle explained: "We made this course with very strong perceptual psychology, human factors content. We look at the physiology of human vision and a little bit of neuroscience. These kinds of things need to be fused into the engineering of virtual reality systems. I think that makes the course very unique and provides principles that survive the test of time."

Nathan Handler (BS CS '15) said, "CS 498SL provided me with my first real experience developing for virtual reality. In class, we got to learn from Oculus's head scientist about the science behind making a pleasant and enjoyable virtual reality interface. We then had the opportunity to practice what we learned by creating our own virtual reality worlds for the Oculus as homework" Handler said that, while developing a VR world was relatively simple and straightforward, "creating an application that provides an enjoyable experience while takes full advantage of everything virtual reality has to offer is a much more challenging task."

The students in the course created 33 projects, mostly in teams of three or four students. The project that dealt with platform rising into the air was to test balance, particularly in older adults, whose balance reflexes could be markedly different from those of younger people. The students measured head movements as participants tried to maintain their balance while they experience the virtual elevation of the platform. More head movements would indicate more balance issues. This project was designed with the help of Professor Manuel Hernandez from Kinesiology.

The project recreating the Assyrian palace of Nimrud was done with the help of Professor Kesh Kesavadas of Industrial and Enterprise Systems Engineering, and with data came from Learning Sites, Inc., and assistance from its CEO Donald Sanders.

So, VR has uses beyond games. "This is not about a platform for video games," said LaValle, and the interest in students and researchers across campus has been growing. LaValle has heard from faculty from such areas as business, linguistics, nuclear engineering, psychology, and neuroscience who see potential uses in their fields for this technology.

As the course continues to develop, LaValle wants it to accommodate the growing interest in VR technology he has seen across campus. Already, the course proved to be extremely popular. It filled quickly for the spring, and the fall section filled up in an hour. As LaValle said, "Students from all over campus want to take it."

Professor Steven LaValle

High School Students Plunge into CS

BY LAURA SCHMITT

Making electronic music, strategizing on how to find a job, creating a digital presence—these are just a sampling of the activities that 250 high school students experienced April 11 as part of CS @ ILLINOIS Splash, a one-day computer science showcase sponsored by Women in Computer Science (WCS) and the Association for Computing Machinery (ACM).

A new event this year, Splash grew out of WCS's ChicTech weekend retreat, which brought 43 female high school students to campus last spring to encourage their interest in computer science, while touting the benefits of studying CS @ ILLINOIS. Splash participants spent the day taking courses, touring the Siebel Center for Computer Science and engineering campus, and interacting with CS undergraduate students.

The day ended with dinner, where the conversations ran the gamut from how cool it was to create a website from scratch, to sharing stories about what it's like to be an undergraduate in CS @ ILLINOIS and what the college decision process was like.

According to Splash co-leader Nathan Handler (CS '15), almost half of the Splash participants were women, and more than 75 CS undergraduates developed and taught 71 different courses throughout the day.

"For me, the most memorable moments were spent talking one-on-one with students and parents," said Handler, who was touched by one mom's effort to drive her son to campus from their home northwest of Chicago early that morning when his transportation plans fell through. "That helped me see that Splash is not just another event for many of the [high school] students. Instead, it is helping to play a key role in determining where they go to school and their futures."

Interestingly, 41 percent of the high school seniors who attended Splash will be studying computer science at Illinois this fall. Although it's impossible to establish a direct correlation, subjectively it seems pretty clear that Splash created a favorable impression in the minds of some high school seniors.

CS senior Briana Chapman teaches high school participants about text encoding techniques and cryptography at the Splash event April 11 in Siebel Center.

In conjunction with Splash, CS @ ILLINOIS presented the National Center for Women & Information Technology (NCWIT) Award for Aspirations in Computing to six female high school students. The department recently launched a regional chapter of NCWIT, a nonprofit community of more than 600 universities, companies, and government organizations nationwide working to increase women's participation in computing and technology.

The following students received the Aspirations award for their leadership, strong academics, and aptitude and interest in IT and computing: Champaign Central High School sophomore Sarah Collins, Normal West High School junior Allyah Evans, Metamora High School senior Jenna Gardner, University High School sophomore Hailan Shanbhag, University High School freshman Hadley Shapland, and University High School freshman Elizabeth Singer.

Before the presentation of Aspiration awards, CS Lecturer Cinda Heeren gave the young women an interactive introduction to computer science concepts by creating a series of new songs based on the notes and rhythms of "Mary Had A Little Lamb." She walked them through the process of analyzing all the possible combinations of notes, translated that information into Python code, and then executed the code to produce a variety of new songs.

"Many of our winners came away from the ceremony marveling at how prestigious the award is," said CS junior Briana Chapman, a former Aspirations recipient who helped present the awards. "[Now they belong to] a nationwide community of alumnae, where they share information, advice, support, and news about scholarships, internships, and coding camps."

Financial support for the day's events was provided by the CS Department. CS @ ILLINOIS extends its appreciation to all of its students who helped make Splash and NCWIT Aspirations awards ceremony a memorable day for the high school youth. Special thanks to student leaders Briana Chapman, Emily Tran (CS '15), Matthew Dierker (CS '15), Nathan Handler, and Corly Leung.

"Both events were excellent examples of the entire department coming together to put on this community event focused on showcasing and inspiring high school students to learn more about Computer Science," said CJ Coleman, the department's associate director of external relations.

CS @ ILLINOIS, which runs the Central Illinois chapter of the National Center for Women & Information Technology (NCWIT), presented Aspiration awards to high school women before the Splash event April 11. Pictured left to right are: WCS President Emily Tran; CS Lecturer Cinda Heeren; Aspirations winner Hailan Shanbhag; CS Associate Head Lenny Pitt; Aspirations winners Elizabeth Singer, Allyah Evans, Hadley Shapland, and Sarah Collins; Splash co-director Briana Chapman; and CS Department Head Rob A. Rutenbar.

Heeren Shares Expertise at Diversity Summit on Reaching Underrepresented Populations, Especially Women

> **We are incredibly excited at the change in women's enrollment that we are seeing, and we are eager to spread the word about this.**

Increasing underrepresented populations is a goal for many universities and programs in the science fields. The College of Engineering has had good success in reaching underrepresented populations. In particular, the number of female students accepting offers of admission grew by more than 27 percent over the past two years.

CS @ ILLINOIS, in particular, has made great strides in this area. In 2012, only 8 percent of entering CS students were women. For the fall 2015 semester, the department's incoming class was 22 percent women. Admissions results now indicate that the percentages of men and women who accept admission are becoming closer and closer.

To share some of the insights the department has gained in this work, CS @ ILLINOIS faculty member Cinda Heeren (CS PhD '04) took part in the Workforce Diversity Summit in Mountain View, California, this past spring. She was part of a panel focusing on the STEM pipeline, and was joined by Tom Torlakson, State Superintendent of Schools, State of California, and Oscar Porter, Executive Director of California's Mathematics, Engineering, Science, Achievement (MESA) Program.

The daylong Summit provided employers with practical strategies for identifying, acquiring, managing, and retaining a diverse workforce.

For the past several years Heeren and others at the department have been working to bring more women into the field. She was instrumental in bringing the Gems Camp to CS @ ILLINOIS. This camp introduces middle school girls to computing and helps them to recognize it as an exciting career for women.

Heeren is also the faculty sponsor for the University of Illinois student organization Women in Computer Science, whose outreach efforts assist with recruiting new women to the major, and whose strong community provides support for them during their academic careers. In addition, thanks to the generosity of alumni to the Engineering Visionary Scholarship Initiative, more large, renewable scholarships are available to women and underrepresented populations where financial challenges play a major part in accepting a university's offer of admission.

"We are incredibly excited at the change in women's enrollment that we are seeing, and we are eager to spread the word about this," Heeren said.

Desai's Gift to Help Women Pursue CS Graduate Studies

BY LAURA SCHMITT

Chirantan J. (CJ) Desai (MCS '95, MBA '95), president of the Emerging Technologies Division (ETD) at EMC, is grateful for the computer science and business education he received at Illinois because it has provided many professional opportunities during his career.

This summer he and his wife established the Chirantan J. (CJ) and Hina Desai Computer Science Fellowship to provide the best women CS graduate students with opportunities to excel, as well.

"I'm very proud of the fact that the Illinois CS program continues to be [among the] top five in the country," said Desai. "I absolutely enjoy my ties with CS, and I'm very humbled that I can contribute my small part in attracting future leaders in the CS discipline."

While pursuing his dual degrees at Illinois, Desai performed research in Loomis Lab under the direction of Physics Professor Paul Handler. He also took a database systems class, which inspired him to join Oracle Corp., where he worked in product development and got opportunities to work on Oracle's early entry in software-as-a-service arena.

In 2004, Desai joined Symantec, the software security, storage, and systems management firm, where he served as senior VP of the Endpoint and Mobility Group, leading engineering, product management, and all related product operations for security products. Later, he served as executive VP of Information Management, leading the strategy, development and delivery of Symantec's backup and recovery, storage and availability, archiving and eDiscovery products.

Since joining EMC in September 2013, Desai has been overseeing ETD's product development, product management, finance, marketing, and sales. ETD develops cutting-edge solutions for the cloud storage and converged infrastructure industries.

"I still get excited about innovation in technology, and I am fortunate to work on very cool disruptive technologies," said Desai. "Even though the number of female graduate students in CS [has] improved recently, I am positive that this fellowship will do its small part in [the] making of a future leader or a scientist."

Chirantan J. (CJ) and Hina Desai and family.

> I still get excited about innovation in technology, and I am fortunate to work on very cool disruptive technologies.

Chirantan J. (CJ) Desai

Celebration of Excellence
Student and Faculty Awards

CS @ ILLINOIS honored the students and faculty who have received important distinctions over the past academic year. We extend congratulations to these individuals whose hard work is a credit to themselves and a source of pride for the department.

Kenichi Miura Award

AKHIL LANGER (MS CS '11, PhD '15) studied several aspects of high performance computing under the guidance of Professors Sanjay Kalé and Udatta Palekar, including power and energy optimizations, load balancing, stochastic optimization, and adaptive mesh refinement. A Siebel Scholar, class of 2012, Akhil will join Intel's Champaign office following graduation, where he will continue his work on these issues.

Graduate Awards

ACM STUDENT RESEARCH COMPETITION, FIRST PLACE, SUPERCOMPUTING 2014
Amanda Bienz

C. L. AND JANE W.-S. LIU AWARD
Xiang Ren

C. W. GEAR OUTSTANDING GRADUATE STUDENT AWARD
Muhammad Naveed

GRADUATE STUDENT OUTSTANDING AMBASSADOR AWARD
Babak Behzad

FENG CHEN MEMORIAL AWARD
Jiho Choi
Anupam Das
Soudeh Ghorbani Khaledi
Jonathan Lifflander
Harshitha Menon
Philip Miller
Muhammad Naveed
Thomas Shull

FENG CHEN MEMORIAL AWARD IN SOFTWARE ENGINEERING
Semih Okur

GRADUATE STUDENT OUTSTANDING SERVICE AWARD
Robert Deloatch
Ryan Musa

KENICHI MIURA AWARD
Akhil Langer

OUTSTANDING TEACHING ASSISTANT, FALL 2014
Konstantinos Koiliaris
Ha Kyung Kong
Kyle Tsai
Le Xu
Jingning Zhang

ROBERTO PADOVANI SCHOLARSHIP
Man Ki Yoon

Undergraduate Awards

C. W. GEAR OUTSTANDING UNDERGRADUATE AWARD
Urvashi Khandelwal
Robert Weber

CRA OUTSTANDING UNDERGRADUATE RESEARCHER AWARD
Urvashi Khandelwal

CROWE HORWATH LLP UNIVERSITY OF ILLINOIS OUTSTANDING JUNIOR COMPUTER SCIENCE SCHOLARSHIP
Hanna Koh
Gregory Pastorek

DANIEL L. SLOTNICK SCHOLARSHIP
Brianna Ifft

DUNCAN H. LAWRIE STUDENT LEADERSHIP AWARD
Matthew Dierker

DUNN SYSTEMS SCHOLARSHIP IN MEMORY OF ARTHUR R. DUNN
Yifan Wang
Dmitriy Zavelevich

FRANZ HOHN AND J. P. NASH SCHOLARSHIP
Shivam Gupta
Charles Rozhon

MICHAEL S. HUGHES AWARD FOR SOFTWARE ENGINEERING
Brian Dahmen
Philip Daian
Walker Henderson
Andrew Kowalski
Daniel Zebrowski
Wenxue Zhang

ICCP JAMES N. SNYDER MEMORIAL AWARD
Benjamin Delaporte

JAMES N. SNYDER AWARD FOR SCHOLASTIC ACHIEVEMENT
Emily Chao
Nicholas Kortendick

JEFFREY P. BLAHUT MEMORIAL SCHOLARSHIP
William Hennessy

JOHN DEERE & COMPANY SCHOLARSHIP
Amanda Sopkin

JOHN R. PASTA AWARD
Jonathan Pierce
Xufeng Zhu

JP MORGAN CHASE WCS SCHOLARSHIP
Emily Chao
Amanda Sopkin

JUMP TRADING SCHOLAR
Abhishek Harish

KNIGHT OF ST. PATRICK
Matthew Dierker
Marrissa Hellesen

SPOT TRADING SCHOLARSHIP
Mariko Wakabayashi

Faculty Awards

AAAS FELLOW
Dan Roth

ACM FELLOW
Vikram Adve

ACM SIGIR TEST OF TIME AWARD
ChengXiang Zhai

ACM SIGKDD DOCTORAL DISSERTATION AWARD, RUNNER UP
Aditya Parameswaran

ACM SIGMOD JIM GRAY DOCTORAL DISSERTATION AWARD
Aditya Parameswaran

CRA BOARD OF DIRECTORS
Sarita Adve

DEAN'S AWARD FOR EXCELLENCE IN RESEARCH
P. Brighten Godfrey

DONALD BIGGAR WILLETT FACULTY SCHOLAR
Saurabh Sinha
Tao Xie

ENGINEERING COUNCIL OUTSTANDING ADVISOR
Marco Caccamo
Matthew Caesar
Roy Campbell
Corina Girju
P. Brighten Godfrey
John Hart
Steve Herzog
Derek Hoiem
Saurabh Sinha
Paris Smaragdis
ChengXiang Zhai

HPC INNOVATION EXCELLENCE AWARD
Paul Fischer

IEEE COMPUTER SOCIETY HARRY H. GOODE MEMORIAL AWARD
David Padua

IEEE COMPUTER SOCIETY TECHNICAL ACHIEVEMENT AWARD
Josep Torrellas

IEEE FELLOW
Paris Smaragdis

PAMI YOUNG RESEARCHER AWARD
Derek Hoiem

SIAM/ACM PRIZE IN COMPUTATIONAL SCIENCE AND ENGINEERING
William Gropp

KENICHI MIURA (MS CS '71, PhD '73) is professor emeritus at the National Institute of Informatics (Tokyo, Japan). His contributions to Fujitsu's VP series of vector supercomputers demonstrated how vectorizing compilers can effectively take advantage of hardware architectures. After winning the IEEE Computer Society's Seymour Cray Computer Engineering Award in 2009, he established the Kenichi Miura Award to recognize excellent CS @ ILLINOIS students working in high performance computing.

Support CS Students

Many of these awards and scholarships are made possible by generous donations from alumni and corporate partners. If you would like to support an existing fund or create a new one, please contact Director of Advancement Michelle Wellens at mwellens@illinois.edu for more information. Gifts are always welcome to support the CS Engineering Visionary Scholarship Fund, which helps us give more and larger scholarships to deserving students. To give online, visit http://cs.illinois.edu/giving/give-now.

Fisher Gift Honors Wife & Endows His Legacy

BY JEFF ROLEY, UI FOUNDATION

When Scott Fisher (BS Psychology '72, MS CS '76) received his second degree from Illinois, inflation was rampant and job prospects were dim. However, he and all of his fellow graduates had interviews with the major computer and electronics corporations. "I asked one recruiter why they came to the cornfields of Champaign," Fisher recalls, "and she said, 'Our relationship with Illinois is critical, and we get great employees from here.'"

To acknowledge the critical role Illinois has played in his life, a seven-figure estate gift will establish the Scott H. and Bonita J. Fisher Endowment, which also honors his late wife, Bonnie, who passed away in 2013. The Fisher Endowment will fund a professorship in both computer science and mathematics, as well as provide funding for the university's main library and the Grainger Engineering Library.

When asked why he chose to leave his legacy at Illinois, Fisher said, "When I was at Illinois, we had some of the giants in computing. They taught, did research, but more importantly, they challenged us. They helped us wonder about how things work and gave us the guidance to figure it out. Bonnie and I believe that Illinois must remain a leader in all these areas—and it must excite the next group of students. We must continue to have the best faculty, staff, and facilities."

Fisher is committed to doing his part to ensure the same level of inspiration and teaching excellence for future generations. Using language in his trust provided by the University of Illinois Foundation—coordinated with a fund agreement laying out the uses of his gift—he can rest assured that his legacy of determination, excellence, and achievement are secure.

The ability to give back is especially gratifying for Fisher because he came from modest family means and started working at age 14. "My parents wanted me to do well and helped me financially. They also encouraged me to save for my education," he said. "I've probably achieved more than they ever thought possible."

Today Fisher lives in Minneapolis and works for Ecolab. "I manage a great group of people who develop applications for R&D and our business," Fisher said. "To this day, my U of I experience helps me provide an exciting and productive environment."

the #lastword

CS @ ILLINOIS is using its social networks
to enhance its connection to students, faculty
and alumni. Are YOU Linked, Liking, and Following?
Here are some excerpts of notable posts:
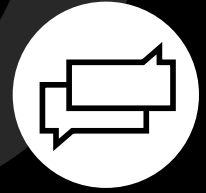
University of Illinois Computer Science

This article [in Fast Company] about "real online dangers" mentions research from #ILLINOIS professors Matthew Caesar, Nikita Borisov, and PhD student Anupam Das: about 50% of people reuse their passwords! That's a real problem if an information breach reveals the password that you've used for several different services.

The University of Illinois makes the list of the 10 best public universities in the U.S.

Congratulations to Ahmed El-Kishky, who was one of five University of Illinois graduate students to receive a National Defense Science and Engineering Graduate (NDSEG) Fellowship.

Dave Paola (BS CS '10) and Roshan Choxi (BS CE '10) co-founded Bloc in 2011 to provide online boot camps in web development, mobile development and software design.

Champaign, Illinois, is the 17th highest city for PhDs in the US. 6.9% of the city's inhabitants have a doctoral degree.

Alumna Nistha Tripathi (MS CS '07) is the founder of Scholar Strategy, an online counseling service for engineers interested in pursuing higher studies in US universities.

@IllinoisCS

Congrats to Prof. Cheng Zhai, who is the recipient of a 2015 Yahoo! Faculty Research & Engagement Program Award!

Gigster, co-founded by Roger Dickey (BS CS '05), provides full-service development shop to help startups.

Study from #Illinois CS PhD student Muhammad Naveed shows fragmented Android development creates security risks.

Microsoft released #VisualStudio 2015 today, incl. IntelliTest tool incorporating work of @IllinoisCS Prof @taoxiease.

UIUC ranked among top universities most likely to land you a job in Silicon Valley.

CS @ ILLINOIS

A Local TV station did a story on one of our graduating seniors, Marrissa Hellesen, who has overcome a lot in her journey to a CS @ ILLINOIS degree. Earlier this semester Marrissa was one of our students who was named a Knight of St. Patrick in the College of Engineering.

Smile Politely, the Urbana-Champaign online magazine, had a really nice story on the GEMS camps sponsored by CS @ ILLINOIS and hosted in the Siebel Center.

The University of Illinois' ILLIAC inspired the Heuristically Programmed Algorithmic computer, more commonly known as HAL, in Arthur C. Clarke's 1968 sci-fi thriller 2001: A Space Odyssey.

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Keep in touch!

We want to stay connected with our alumni and friends. To share your latest career news and update your contact information, please email us at: **click@cs.illinois.edu** or scan the QR code to use our online form: **go.cs.illinois.edu/KeepInTouch**

THE SECOND ANNUAL HACKILLINOIS BY THE NUMBERS: NEARLY 1,000 STUDENTS OVER 36 HOURS, 180 PROJECTS, 47 TEAM PRIZES, AND OVER 200 VOLUNTEERS. AND ALREADY PLANNING FOR NEXT YEAR: FEBRUARY 27-MARCH 1, 2016.

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PHOTO BY PRITEN VORA

To see the CS Master Calendar, please visit:
go.cs.illinois.edu/calendar