

# click!

MAGAZINE 2016, VOLUME II

## From Computational Genomics to Precision Medicine

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# CS @ ILLINOIS COMPUTER SCIENCE

## Department of Computer Science

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

**WE DO THE IMPOSSIBLE EVERY DAY.**



Department Head: Rob A. Rutenbar

CS @ ILLINOIS continues to be the most popular major on the Illinois campus and we are exploring how we can grow to better accommodate both the titanic student interest and industry's demand for our highly talented graduates. We remain committed to providing the highest-quality student experience as we innovate curriculum and hire more faculty—ten stellar additions just this year (see p. 6). We welcome our alumni and friends to partner with us on recruiting, research collaborations, and philanthropy to uphold our rankings and global reputation as a leader in computer science education and research.

*Click! Magazine* is produced twice yearly for the friends of CS @ ILLINOIS to showcase the innovations of our faculty and students, the accomplishments of our alumni, and to inspire our partners and peers in the field of computer science.

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# GET INVOLVED!

## Build the Talent Pipeline

CS @ ILLINOIS has developed programming throughout the year to engage and inspire more young people to explore the fun and diverse applications of computer science.

- **Girls Who Code** chapter—ongoing programming for local girls
- **Sail** (April): a day of student-run workshops targeted for high school students
- **NCWIT Aspirations Awards** (April): recognizes high school girls for their interest in computer science
- **Gems Computer Science Camp for Girls** (June & July): 6 weeks of day camp for middle and high school girls
- **ChicTech Retreat** (November)—an overnight retreat for high school girls
- **Hour of Code** (December)—open labs for coding fun for the whole family

All of these outreach activities are funded by the CS Department, alumni donations, and corporate partners. To get involved, email [cs-outreach@illinois.edu](mailto:cs-outreach@illinois.edu).

## Continue Your Education

Keep your skills on the cutting edge. Explore the CS Graduate Programs, Illinois Online offerings, or MOOCs through the Illinois-Coursera Partnership.

## Stay Active with CS Student Groups

The **CS-Affiliated Student Groups** are strong and as active as ever. They are eager for alumni to stay involved, and welcome corporate partners to participate in events.

- **HackIllinois** (February)
- **ACM Showcase** (April)
- **WCS Alumni & Student Banquets** (April & October)
- **ACM Reflections | Projections Conference** (Fall)

## Join in the CS @ ILLINOIS Alumni Network

Keep the **CS @ ILLINOIS Alumni Network** strong—attend or host a regional CS networking event in some of our high alumni population cities across the country. We have plans to be in Chicago, New York, and San Francisco on regular cycles. Keep an eye out for e-invites. Make sure your contact info is up to date with us!

## Share Your Expertise with Current Students

Schedule a custom **Engineer in Residence** experience where you can meet with faculty, give a presentation, attend or speak in a class, meet with student groups, and tour the newest areas of campus. Email Michelle Wellens at [mwellens@illinois.edu](mailto:mwellens@illinois.edu) to schedule your campus visit today.

## Visit Campus for CS Awards and Homecoming

CS @ ILLINOIS joins forces with our student groups, including ACM, to jointly host the **WCS Alumni & Student Dinner** and the **CS @ ILLINOIS Distinguished Alumni Awards**. Held in conjunction with Homecoming, this is the best time to visit campus to deeply engage with CS faculty, students, and fellow alumni. Enjoy panels, networking events, campus tours, tailgating, and football. **Join us: October 27–29, 2016.**

## Become a Corporate Partner

We encourage alumni to connect their companies to CS @ ILLINOIS to establish recruiting relationships and to explore sponsored research opportunities. Visit [cs.illinois.edu/corporate](http://cs.illinois.edu/corporate) to learn more.

## Take the CS Alumni Engagement Survey

Tell us how to best connect with you and develop communications and engagement activities that interest you. We'd also like to know about your affinity with our student groups and get your thoughts about philanthropy. Visit: [go.cs.illinois.edu/alumnisurvey](http://go.cs.illinois.edu/alumnisurvey).

## Be Philanthropic

Learn how making a gift—of any size—can really make a difference in supporting current students. Visit: [cs.illinois.edu/give](http://cs.illinois.edu/give).



Visit the redesigned CS Website to learn more  
[cs.illinois.edu/get-involved](http://cs.illinois.edu/get-involved)





Steve Chen (attendee through 1999)

## Steve Chen's Tasty New Startup

YouTube cofounder Steve Chen (attended through 1999) has started a food-focused, live streaming multimedia site called Nom, which enables food lovers to create, share, and watch their favorite stories in real-time. What sets Nom apart from other live-streaming services is its level of interaction.

Any foodie can direct, produce, and host his/her own broadcasts. In addition, viewers can learn from their favorite chefs, brewmasters, grillmasters, baristas, or bloggers by asking questions or having a two-way chat via text, photos, or video. Launched at the South by Southwest music festival in Austin in March, Nom received \$4.7 million in funding during the spring of 2016.

Earlier in his career, Chen worked at PayPal, where he met his YouTube cofounders Jawed Karim (BS CS '04) and Chad Hurley. The trio launched YouTube in 2005 and Chen served as CTO during and after its acquisition by Google.

Since leaving YouTube, Chen has been heavily involved in startups and incubators, forming AVOS (which launched MixBit, AVOS China, and Delicious) and serving as an Entrepreneur In Residence with Google Ventures. He received a CS @ ILLINOIS Distinguished Alumni Achievement Award in 2014.

## Microsoft Acquires Ozzie's Latest Startup

In December 2015, Microsoft bought Ray Ozzie's (BS CS '79) Boston-based startup, Talko, the maker of an innovative mobile app for on-the-go business communications. As part of the agreement, Talko employees joined Microsoft and will work on delivering new features and capabilities in both Skype and Skype for Business.

A software visionary and entrepreneur, Ozzie chose not to rejoin Microsoft, where he served as chief software architect (2006–2010) and designated successor to Bill Gates. Currently, Ozzie is a member of Hewlett Packard Enterprise's Board of Directors.

Talko was Ozzie's third major startup. In 1997, he founded Groove Networks, which created decentralized collaboration software both for individuals and enterprises; the company was purchased by Microsoft in 2005. In 1984, he founded Iris Associates, where he created Lotus Notes, a groupware and email product used by more than 120 million people at corporations worldwide for collaboration within large enterprises. Iris was purchased by Lotus Development in 1994, and by IBM in 1995.



Ray Ozzie (BS CS '79)

A member of the Engineering at Illinois Hall of Fame, Ozzie received an honorary doctorate from his alma mater in 2012.

nom™

talko

Microsoft

## New Levchin Prize Rewards Advances in Real-world Cryptography

Internet entrepreneur Max Levchin (BS CS '97) has established an international award to celebrate and promote cryptography and its applications in digital security, while raising public awareness of its importance.

"I created this prize because I believe technological innovation can improve electronic freedom, privacy, trustworthiness, and safety," Levchin stated in a post on LinkedIn in January. "All of us use—and benefit from—applications of cryptography in our daily lives. More than anything, this prize is about drawing attention to the contributions of those in the field and recognizing that cryptography is a very special field, in and of itself."

The first Levchin Prizes for Real-World Cryptography were presented in January 2016 to a University of California-Davis CS professor and an international team of researchers from Microsoft and a French national research institution.

Professor Rogaway received his \$10,000 prize for groundbreaking work on authenticated encryption and format preserving encryption. The international team shared its \$10,000 award for developing a verified implementation of the Transport Layer Security (TLS) protocol and uncovering numerous mistakes in the design of TLS and mistakes in many other implementations.

Levchin, who is the founder and CEO of financial services technology company Affirm and chairman of women's reproductive health company Glow, considers the prize a seed investment and hopes to attract interest from other supporters to elevate the monetary portion of the award in 2017 and beyond.



Max Levchin (BS CS '97)

## Levchin's Affirm Earns Innovative Company Recognition

Affirm, the financial technology company co-founded by Max Levchin (BS CS '97), was named a Most Innovative Company of 2016 by *Fast Company*. Ranked 41st overall and second in Finance, Affirm was praised for trying to reinvent the financial ecosystem by using data and software.

Affirm brings simplicity, transparency, and fair pricing to consumer credit, allowing customers to take out microloans at the point of sale with participating vendors. Customers enter their basic information and know quickly if they've been approved for a loan. Rather than simply looking at a customer's FICO score, Affirm evaluates things like social media activity to determine financial responsibility, which makes the company popular among millennials.

A serial entrepreneur, Levchin co-founded Affirm in 2013. Earlier in his career, Levchin co-founded PayPal, the popular online money and payment exchange service, where he served as the company's chief technology officer and was responsible for developing anti-fraud measures. In 2004, Levchin founded Slide, a media-sharing service for social networking sites, and helped start Yelp, the online social networking and review service.

Levchin was inducted into the Engineering at Illinois Hall of Fame in 2014, and he received the CS @ ILLINOIS Distinguished Alumni Achievement Award in 2011.



## C3 Energy Becomes C3 IoT

During the last seven years, Tom Siebel's (BA History '75, MBA '83, MS CS '85) company, C3 Energy, developed big data integration and analytics software for the power grid, whose embedded sensors tracked the generation, delivery, and use of electricity. More than 20 companies in Europe and the United States were using C3's applications.

In February 2016, Siebel renamed his company C3 IoT to reflect its broadening customer base and expanding markets as its Internet of Things platform matured. Among C3's targeted new industries are oil and gas, manufacturing, aerospace, automotive, chemical, pharmaceutical, facility operations, telecom, retail, insurance, financial services, and government, defense, and intelligence agencies.

The C3 IoT platform enables organizations to leverage all available data—including telemetry from sensors and devices, data from diverse enterprise information systems, and external data sources like social media, weather, traffic, and commodity prices—while employing advanced analytics and machine learning at scale, in real time, to capture business insights for improved operations, enhanced customer engagement, and differentiated products and services.

A well-known entrepreneur and philanthropist, Siebel was the founder, chairman, and chief executive officer of Siebel Systems, a customer relationship management (CRM) software firm that was acquired by Oracle in 2006. Through the Thomas and Stacey Siebel Foundation, he supports a number of initiatives in education, health, drug prevention, energy solutions, and support for the homeless.

At Illinois, he has established the Thomas M. Siebel Center for Computer Science and endowed two chaired professorships.



*Tom Siebel (BA History '75, MBA '83, MS CS '85)*

## Eich Launches New Company Promising Faster, Safer Web Browsing

Brendan Eich (MS CS '86), co-founder of Mozilla, the company that created the Firefox web browser, has launched a new company—Brave Software—that promises to make web browsing faster and safer while growing ad revenue share for content creators.

In an effort to avoid poorly designed or slow loading ads, as well as to thwart malware, the use of tracking cookies, and the collection of personal data, some users have resorted to ad blocking software. However, these programs can make it difficult for content creators like news and entertainment sites to collect ad revenue that they use to sustain their business. Brave proposes a new ad revenue sharing solution that supports publishers.



*Brendan Eich (MS CS '86)*

The Brave web browser blocks intrusive ads and replaces them with ads that the company says are more relevant to a user's interests, won't compromise a user's privacy, and load quickly.

The Brave model gives 55% of ad revenues from the replacement ads directly to publishers, 15% to its users who can either keep the money or donate it to the publisher, and 15% to ad partners; Brave keeps the remaining 15%.

Eich, who is well known for creating the JavaScript programming language in the 1990s, is serving as CEO of Brave Software, which raised \$2.5 million in funding in late 2015. Development versions of the browser are available at the company's website for Windows, Mac OS, Linux, and mobile operating platforms.



# Ceze and Strauss Reach Research Milestone in DNA-based Data Storage

University of Washington Associate Professor Luis Ceze (PhD CS '07) and Microsoft Computer Architect Karin Strauss (PhD CS '07) recently made headlines for their work on storing digital information in DNA. Ceze and Strauss were part of a team that successfully wrote a record 200 megabytes of data, including a music video and top literary classics, in DNA strands that, collectively, were smaller than the tip of a pencil.

"Life has produced this fantastic molecule called DNA that efficiently stores all kinds of information about your genes and how a living system works — it's very, very compact and very durable," said Ceze in a University of Washington news release. "We're essentially repurposing it to store digital data — pictures, videos, documents — in a manageable way for hundreds or thousands of years."

Demand for data storage is growing exponentially and existing storage methods like magnetic tapes housed in massive data centers are struggling to keep up. "If you look at current projections, we can't store all the information we want with devices at the costs that they are," said Strauss in an interview with *MIT Technology Review*.

Although the team has a long way to go to make DNA a viable archival option, they have reason to be optimistic since they have increased the storage capacity one thousand times during the last year.

Photos courtesy of Microsoft.



Professor Luis Ceze



Dr. Karin Strauss



Dr. Milos Gligoric (PhD CS '15)

## Gligoric Receives ACM SIGSOFT Dissertation Award

Dr. Milos Gligoric (PhD CS '15) is the 2016 recipient of the ACM SIGSOFT Outstanding Doctoral Dissertation Award. The award recognizes excellent research in the field of software engineering.

Titled "Regression Test Selection: Theory and Practice," Gligoric's dissertation presents an innovative solution that substantially speeds up regression testing for modern software development environments. Widely used in industry, regression testing is the process of verifying that software still performs correctly after changes. While regression testing is a crucial activity, it is also expensive. Ekstazi, Gligoric's practical Java-based tool that implements his work, can speed up testing by an order of magnitude. It has been adopted by several open-source (for example, Apache Camel) and proprietary projects.

Advised by CS Associate Professor Darko Marinov, Gligoric is currently an Assistant Professor in Electrical and Computer Engineering at the University of Texas at Austin. At Illinois, he received several honors, including two ACM SIGSOFT Outstanding Paper Awards, the David J. Kuck Outstanding PhD Thesis Award, the C.W. Gear Outstanding Graduate Student Award, the C.L. and Jane W.S. Liu Award, a Mavis Future Faculty Fellowship, and the Saburo Muroga Fellowship.



# CS @ ILLINOIS Welcomes Ten New Faculty



## ADAM BATES

### Assistant Professor

In 2016, Adam Bates received his PhD from the University of Florida, where he was a founding graduate student of the Florida Institute for Cybersecurity. His research confronts issues of security and transparency in computer systems and networks. Within this broad area, Bates has conducted research on a variety of security topics, including SSL/TLS, cloud computing, USB, financial services, and telephony infrastructure.

His recent work has evaluated the security of mobile financial applications, introduced mechanisms that defend against USB-based attacks, and designed security-enhanced provenance-aware systems that are capable of reliably tracking and explaining system intrusions.

Bates received his BS in Computer Science in 2006 from the University of Maryland and his MS in Computer Science in 2012 from the University of Oregon. He has participated in graduate internships at MIT Lincoln Laboratory and EMC.



## TIMOTHY M. CHAN

### Founder Professor of Engineering

An intellectual leader in computational geometry, Timothy Chan is joining the CS @ ILLINOIS faculty in January 2017. He has been a faculty member at the University of Waterloo since 1999.

Chan has broad interests in algorithms and theoretical computer science, and he's known for many breakthrough results in the area of computational geometry. For example, he developed faster algorithms for computing convex hulls and data structures for nearest neighbor search. His current research continues to explore new fundamental techniques for processing large-scale geometric data sets.

A winner of the NSERC Doctoral Prize, Chan earned his PhD in computer science from the University of British Columbia in 1995; he completed a one-year postdoc at Johns Hopkins and then joined the University of Miami faculty as an assistant professor for three years before moving to the University of Waterloo.



## DAVID CHU

### Associate Professor

A researcher in Microsoft's Mobility and Networking Research Group, David Chu will join the CS @ ILLINOIS faculty in the fall of 2017. Chu's research interests are in mobile systems and applications, cyber-physical systems, sensing systems, ubiquitous computing, and applied machine learning. His current work focuses on low-latency perception-aligned mobile systems, and he has contributed to Windows, Windows Phone, Xbox, and HoloLens products.

Specifically, Chu's work aims to understand what it takes for mobile devices to operate at the speed of human perception. He has worked on the Outatime project, a speculative execution system for app streaming that masks network latency and has been implemented on two high-quality, commercially-released twitch-based games.

Chu has also worked on a Kinect-like device tracking system that can fully support dynamic human motion in real-time. He received the MobiSys 2015 Best Paper Award and the MobiSys 2014 Best Demo Award.





## NEAL DAVIS

### Teaching Assistant Professor

Neal Davis received his PhD in 2013 from the Department of Nuclear, Plasma, and Radiological Engineering at the University of Illinois, where he simulated uranium surface chemistry using density functional theory and kinetic Monte Carlo modeling. He also studied chemical engineering and high-performance computing.

Davis has worked with the U of I Computational Science and Engineering program on developing, promoting, and teaching best practices for engineering and scientific software. He has also worked closely with Software Carpentry since 2013, teaching open science techniques, reproducibility, and task automation to domain researchers.

This fall, Davis was promoted from lecturer to his current position. He continues to promote the communication of key software development concepts and technical best practices between the engineering and CS communities.

Davis' scholarly interests include science and engineering pedagogy, nuclear materials science, high-performance computing applications, and the history and philosophy of science and technology.



## CHRISTOPHER FLETCHER

### Assistant Professor

Christopher Fletcher received his PhD from MIT in 2016. His research interests span computer architecture, high-performance computing, security, and applied cryptography. He will join CS @ ILLINOIS in the fall of 2017 after completing a postdoc at NVIDIA Research.

Fletcher's research focuses on how to build secure systems in the presence of powerful adversaries. A major theme in his work is to bring cryptographic techniques from theory to practice: studying not only the techniques' asymptotics, but also the constant factors and low-level implementation details that become important in the eventual system.

His doctoral work, which explored building a prototype secure processor in silicon to inventing asymptotically better cryptographic algorithms, received two best paper awards and was named as one of *Scientific American's* 10 "World Changing Ideas" in 2013.



## MICHAEL FORBES

### Assistant Professor

Michael Forbes, who will join the CS @ ILLINOIS faculty in June 2017, is conducting research on the interaction of randomness, algebra, and computation. Many of today's computer programs heavily use random bits, the results of digital coin flips, to ensure efficiency. Despite decades of study, whether such randomness is essential remains a fundamental open question. This question is even open for the class of algebraic computation, where the primary operations are the familiar notions of addition and multiplication from mathematics.

Forbes' research has removed the need for randomness in important examples of algebraic computation, and in doing so, has drawn novel connections with linear algebra, the complexity of mathematical proofs, and invariant theory.

Forbes earned his doctorate in computer science at MIT in 2014, and he's currently working as a postdoctoral researcher at Stanford and the Simons Institute's program on Pseudorandomness.



## GEOFFREY L. HERMAN

### Teaching Assistant Professor

Geoffrey Herman has worked with the University of Illinois Foundry for Innovation in Engineering Education for the past four years helping faculty to reimagine engineering curricula and courses. His efforts have helped improve the College's ability to teach effectively at increasingly large scale and integrating computational skills into engineering courses.

After earning his doctorate in Electrical and Computer engineering from Illinois, Herman conducted postdoctoral research in the School of Engineering Education at Purdue University. His research interests include studying how students learn computing concepts and creating systems for sustainable improvement in engineering education. He has been awarded over \$5 million in funding to improve and study CS and engineering education, and he has published over 60 peer-reviewed articles.

As an Illinois faculty member, Herman was awarded the Olesen Award for Excellence in Undergraduate Education and has been included in the *List of Teachers Ranked as Excellent*.



## SIBIN MOHAN

### Research Assistant Professor

Sabin Mohan's research interests lie at the intersection of systems and security – for embedded, cyber-physical and real-time systems, cloud computing, software defined networking, and the Internet-of-Things (IoT). He's the University of Illinois lead for a National Science Foundation-funded \$4 million multi-university project to develop secure and automatically reconfigurable manufacturing plants.

Mohan continues his affiliation with the U of I Information Trust Institute (ITI), where he was a research scientist prior to joining the CS @ ILLINOIS faculty. At ITI, Mohan leads multiple projects that aim to improve the security of real-time and embedded systems from a design perspective, as well as to detect intrusions in existing systems. He also explores the use of software-defined networking in safety-critical systems and security for lightweight cloud computing platforms. His work has applications in avionics, automotive systems, and power grids.

Prior to joining ITI, Mohan was a postdoctoral researcher with CS @ ILLINOIS; he received his PhD from North Carolina State University in 2008.



## EDGAR SOLOMONIK

### Assistant Professor

Illinois alumnus Edgar Solomonik (BS CS '10) earned his doctorate from the University of California – Berkeley in 2014 and then worked as a postdoctoral researcher at ETH in Zurich, where he demonstrated the applicability of his work on algebraic algorithms to other domains.

His current work develops parallel algorithms for scientific and combinatorial problems. Oscillating between optimization of numerical libraries on supercomputers and purely theoretical analysis, Solomonik's research evolved rapidly, culminating in results that blur the lines between applied mathematics and computer science.

Outside of CS, Solomonik's work has had an impact on the computational quantum chemistry community. His work on communication-avoiding algorithms for matrix and tensor (multidimensional matrix) problems has led to new methods that are less costly and more scalable. In addition, he has led the development of a parallel library for tensor computations, bringing petascale performance to the most accurate methods for studying molecular structure and chemical reactions.



## MATUS TELGARSKY

### Assistant Professor

Matus Telgarsky's research interests are in the theoretical foundation of machine learning. Since earning his doctorate in 2013 at University of California – San Diego, he has focused on designing new standard linear prediction algorithms and boosting algorithms.

At Illinois, Telgarsky will explore neural networks and non-convex optimization problems, a topic he'd recently been working on at the University of Michigan as a postdoctoral researcher. Algorithmic solutions to these problems can be applied to engineering product design, economics, financial options pricing, and radiation therapy.

Telgarsky has shown that depth can help neural networks. In fact, there are certain problems where a polynomially sized deep network outperforms every shallow network of sub-exponential size. During an internship at Microsoft Research, Telgarsky helped demonstrate that the structure of many latent variable models can be discerned by running a power method on a tensor constructed from observed data.



# Peng One of Five Illinois Faculty Named Sloan Research Fellows

BY SARAH BANDUCCI, U OF I NEWS BUREAU

CS Professor Jian Peng was one of five University of Illinois faculty members who received the 2016 Sloan Research Fellowship from the Alfred P. Sloan Foundation.

This year, 126 Sloan Research Fellowships were awarded to early-career scientists and scholars from 52 colleges and universities across the United States and Canada, including 12 in Computational and Evolutionary Molecular Biology, Peng's area of research. Senior scholars chose awardees from nominated candidates based on research accomplishments, creativity, and leadership potential in the candidate's field. Each will receive \$55,000 to pursue further research.

Peng joined CS @ ILLINOIS in 2015. His research focuses on computational biology and machine learning. In particular, his research group develops advanced computational techniques for studying the molecular mechanisms of human diseases, predicting protein structure and function and analyzing large-scale biological data sets.

Other recipients from Illinois include Elena Fuchs (Mathematics), Kami Hull (Chemistry), Joaquín Rodríguez-López (Chemistry), and Yue Shen (Astronomy).

## Faculty Startup Veriflow to Eliminate Change-Induced Outages and Breaches

Veriflow, led by Ahmed Kurshid (PhD CS '15) and CS professors Matthew Caesar and Brighten Godfrey, launched in April with \$2.9 million in initial investor funding from New Enterprise Associates (NEA), the National Science Foundation, and the Department of Defense. Two months later, the network breach and outage prevention company created in the EnterpriseWorks incubator at the University of Illinois Research Park, announced that it had secured \$8.3 million in Series A funding, led by NEA and Menlo Ventures.

It is the first networking company to use formal verification to eliminate change-induced network outages and breaches. Veriflow's award-winning mathematical network verification technology gives organizations the confidence to make changes by eliminating risks associated with modifying the network. The software also ensures network policy correctness and sends alerts whenever any change that may impact the network is detected, including intentional changes due to insider sabotage.



"There's no reason why networks can't be just as trustworthy as other mission-critical devices and applications. And we've figured out how to protect networks from change-induced outages and breaches mathematically," said Godfrey, who is CTO at Veriflow.

Ahmed Kurshid (PhD CS '15)



Professor Matthew Caesar



Professor Brighten Godfrey



# Torrellas Elected to CRA Board of Directors



CS Professor Josep Torrellas was recently elected to the Computing Research Association (CRA) Board of Directors, joining fellow CS Professor Sarita Adve. Founded in 1972, the CRA brings together industry, government, and academia to strengthen research and advanced education in computing.

“I look forward to helping broaden the scope of computing research, amplify its impact on society, nurture computing researchers, and make the case for computing research in the federal government,” said Torrellas, who has been active in CRA-related organizations and events. He recently completed a three-year stint as Council Member of the Computing Community Consortium, which focuses on catalyzing computing research initiatives at the national level.

A pioneer in shared-memory multiprocessor architectures, Torrellas has made important research contributions to cache hierarchies, coherence protocols, synchronization, consistency models, and thread-level speculation. His contributions make it easier to program multiprocessor machines while enhancing their performance. Today, Torrellas is conducting research to make the multicores in smart phones and tablets more programmable, energy efficient, and secure.

Torrellas is a Fellow of the IEEE and ACM. In 2015, he received the IEEE Computer Society Technical Achievement Award. He has graduated 36 doctoral students, many of whom are now leaders in academia and industry.

## Smaragdis Honored with Dean’s Award



At the College of Engineering’s 2016 Faculty Awards Ceremony this spring, Professor Paris Smaragdis was recognized with the Dean’s Award for Excellence in Research. He was one of only five assistant professors across the College recognized for their outstanding research with this award.

Smaragdis works in Machine Listening, a field that designs and builds computational systems to sense and understand sound. He is well-known for his work to address a core challenge in the discipline, the so-called “cocktail party” problem. This is when a system must extract one sound from an overlapping mixture of sounds, like one person’s voice at a noisy party.

To address this problem, Smaragdis pioneered the application of non-negative matrix factorization methods, originally devised for analyzing images, to audio source separation. This has become one of the main approaches in the field. He was also one of the first to apply deep neural networks to audio source separation, with several exciting recent results. These include a general monaural source separation framework that’s able to jointly model all audio sources within a recording as targets for neural networks.

Already an IEEE Fellow, Smaragdis’s other honors include an NSF CAREER Award and selection to *MIT Technology Review*’s list of Innovators Under 35.



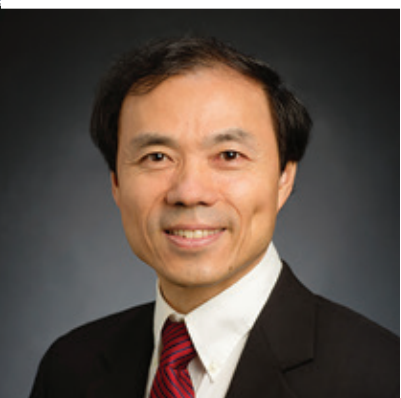
## Zhai and Herzog Among Faculty and Staff Honored for Excellence

CS Professor ChengXiang Zhai and CS Coordinator of Academic Programs Steve Herzog were two of over twenty Illinois faculty, staff, and graduate teaching assistants who were honored on April 26 for excellence in teaching, mentoring, and advising. Each was recognized during a reception at the Alice Campbell Alumni Center.

Zhai was recognized for being a truly outstanding, dedicated, and supportive advisor, having mentored more than 60 graduate students. He is very passionate about research

and teaching, and shares this passion with his students. He has an ability to identify a student's strengths and put the student on a project that he or she can be enthusiastic about.

Herzog was recognized not only for outstanding one-on-one advising, but also for his contributions to student success and well-being through implementing policies and creating widely used departmental resources. Herzog is the "data czar," responding to requests from many throughout the department.



## Parameswaran Co-Authors Book on Crowdsourcing

In their new monograph, *Crowdsourced Data Management: Industry and Academic Perspectives*, CS Professor Aditya Parameswaran and his co-author, Dr. Adam Marcus, seek to bridge the gap between industry practice and academic research in the emerging field known as crowdsourcing.

There are many tasks that humans do better than computers, especially those that deal with processing images, video, and raw text. However, humans can be expensive, slow, and inaccurate, making crowdsourced tasks hard to orchestrate.

Unfortunately, until recently, crowdsourcing was little-studied by computer scientists. "Companies don't talk about it," Parameswaran explained, "either

because they consider that their 'secret sauce,' or [because] just saying, 'Hey, at the backend, we have a bunch of humans doing the annotation' doesn't make for a sexy technology story."

The co-authors, who have each published extensively on crowdsourcing, summarize cutting edge academic research on crowd-powered algorithms to make it accessible to industry practitioners. They also survey industry users and marketplace providers to explore current solutions and uncover real-world problems that researchers need to address.





# CS Professor Helps Chart NSF's Future Advanced Computing Strategy and Programs

BY LAURA SCHMITT



An internationally recognized expert on high-performance computing, CS Professor William D. Gropp, the Thomas M. Siebel Chair in Computer Science, recently co-chaired a National Academies study that guides the National Science Foundation's future directions in advanced computing. The study's recommendations aim to maintain America's leadership in science and engineering, ensure that resources meet community needs, aid the scientific community in keeping up with the revolution in computing, and sustain the infrastructure for advanced computing.

**// This study provides a framework that can guide the planning and use of advanced computing resources in a way that sustains the investment in people, software, and hardware for the next decade. //**

Gropp and his team solicited input from more than 60 individuals, research groups, and organizations in the advanced computing field. Advanced computing capabilities, including computer systems and expert staff, are typically shared among multiple researchers, institutions and applications, and they help tens of thousands of researchers each year expand the frontiers of science and engineering.

By combining superfast and secure networks, cutting-edge parallel computing, efficient software, state-of-the-art scientific instruments, and massive datasets with expert staff, the NSF-funded advanced

computing ecosystem lets researchers investigate highly complex and computationally intensive problems such as the origins of the universe, unraveling diseases, and climate prediction.

Among the study's recommendations are that NSF should:

- sustain and grow its investments in advanced computing to ensure that the nation's researchers can continue to work at the frontiers of science and engineering.
- collect community requirements and create roadmaps to set priorities better and make more strategic decisions about advanced computing beyond 2020.
- pay close attention to providing support for the revolution in data-driven science along with simulation, including large-scale simulations and/or data analytics that would otherwise be unavailable to researchers and continue to monitor the cost-effectiveness of commercial cloud services.

According to Gropp, NSF's support for advanced computing has been essential for the advancement of science and engineering. "Partly as a result, the demand for advanced computing has been growing exponentially, and NSF and the computational science community need to work together to ensure the uninterrupted availability of the types of advanced computing needed by researchers," Gropp said. "This study provides a framework that can guide the planning and use of advanced computing resources in a way that sustains the investment in people, software, and hardware for the next decade."

To read full report:  
<http://bit.ly/2cUZDoF>



## CS Weekend Inspires High School Students and Their Parents

As the Central Illinois Chapter of the National Center for Women in Information Technology's (NCWIT) Aspirations in Computing Awards, CS @ ILLINOIS hosted the recognition ceremony on April 9 in conjunction with CS @ ILLINOIS Sail. Both events allow the department to engage with pre-college students to promote interest in technology and computer science.

This year five high school girls received Aspirations in Computing Awards. In addition, two prior recipients and current Illinois students, Daniela Markazi and Monika Janas, described the impact Aspirations and computing have had on their lives. CS senior Bri Chapman, a 2011 Aspirations recipient, was the featured speaker for the ceremony. She discussed the use of innovative computing animation technology, including the problems and solutions involved in animating hair, which was a key part of such films as *Tangled* and *Brave*.

Following the Aspirations ceremony was the second annual CS @ ILLINOIS Sail event—a student-driven day of workshops developed to target high school students, especially those admitted to Illinois. Current CS students taught well over 200 attendees about the Linux operating system, data science, programming in Python, among other topics, and shared their excitement about being a CS student at Illinois. A popular addition to this year's event was a track for attendees' parents, which included a departmental overview from CS Associate Department Head and Director of Undergraduate Academic Affairs Lenny Pitt and Undergraduate Advisor Heather Zike, and opportunities to ask questions of a panel of current college students and attend building and lab tours.



*Above, recipients present at the 2016 NCWIT Aspirations in Computing awards ceremony: Anisha, Zoleen, Bell, and Lilly.*

*Right, CS @ ILLINOIS Sail attendees' parents enjoyed a long stop in Siebel Center's virtual reality lab.*




### Help Build the Computing Talent Pipeline

CS @ ILLINOIS is the Central Illinois Affiliate of the NCWIT Aspirations in Computing Program, a talent pipeline initiative to encourage and support high potential technically inclined women. High school students, educators, and college students can earn recognition, prizes, and network. Applications open each September 1 and the recipients are recognized on campus each April in conjunction with the CS @ ILLINOIS SAIL event.

**APPLY NOW!**

<https://www.aspirations.org>





# From Computational Genomics to Precision Medicine

BY LAURA SCHMITT

When the first human genome was mapped more than a decade ago, it heralded the beginning of a potentially revolutionary era in healthcare. Precision medicine—using an individual’s specific genetic profile to help prevent, diagnose, and treat disease—seemed to be on the horizon. Thanks to rapidly decreasing costs of sequencing and analyzing genomes, researchers were hopeful that advances in precision medicine would quickly accelerate.





There has been some progress. For example, scientists have mapped gene mutations to specific diseases and disorders, including cystic fibrosis, melanoma, as well as lung and breast cancers. And patients with certain types of cancers routinely undergo molecular testing as part of their care, enabling physicians to prescribe drugs that target only cancerous cells once they understand a tumor's genetic makeup. The result? Improved survival rates and less adverse patient side effects.

However, even proponents of precision medicine still await the widespread breakthrough that many predicted. One of the barriers is that many diseases don't correlate directly to a single gene. For example, there are at least 65 genetic variations that increase the risk of developing Type 2 diabetes. Some researchers believe that if they can collect and analyze more genome data, then they may be able to identify every possible mutation that could be a factor in many diseases.

The Obama administration's Precision Medicine Initiative is beginning to collect the medical records and genomic data of one million American volunteers. At the same time, massive amounts of already collected genomic data is being publicly released to researchers—e.g., the National Cancer Institute's Genomic Data Commons database, which contains 12,000 cancer patients' data, will enable researchers to access clinical information about cancer tumors and the efficacy of specific treatments.

This proliferation of genomic Big Data presents a unique set of challenges when it comes to acquiring, storing, distributing, and analyzing the data. According to CS Associate Professor Saurabh Sinha, who studied the issue with researchers from Cold Spring Harbor Lab and fellow Illinois faculty, genomic information from sequencing different organisms and a number of humans is



Professor Jiawei Han



Professor Saurabh Sinha



PhD student Sheng Wang



Professor Cheng Zhai



already at the petabyte scale—a petabyte is 1 million gigabytes. By 2025, genomic data will, by their projection, reach the exabyte scale, or billions of gigabytes. To put this in perspective, genomic data may surpass YouTube and come close to matching astronomy as the reigning Big Data Source.

“The DNA sequence in itself is not particularly useful for realizing all the great possibilities that genomics technology promises,” said Sinha, when his team’s study was published in July 2015. “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.”

Several CS @ ILLINOIS faculty are developing the computational analysis tools and methods that will not only make sense of the data, but will also provide the necessary security and privacy safeguards.

## Creating a Knowledge Engine for Genomics

A relatively new way for scientists to identify genes involved in human disease, genome-wide association studies have discovered some genetic variations that contribute to macular degeneration, type 2 diabetes, Parkinson’s disease, obesity, and heart disorders. However, these studies haven’t resulted in a slew of new therapies.

“The big lesson doing these genome-wide association studies for the last 10 years is they’re not as powerful in revealing the underlying source of biological conditions as we would have expected,” noted Sinha, who is also a member of the U of I Carl Woese Institute for Genomic Biology. “The realization is that we need to tie in these studies’ data and analyses with what we already know about biology at the molecular level. The genomics community has generated vast bodies

of knowledge that could be incorporated here, but other than some crude methods, there’s no systematic way to do that now.”

Sinha and CS Professor Jiawei Han hope to change that. Funded by a \$9.3 million grant from the National Institutes of Health’s Big Data to Knowledge (BD2K) initiative, they have partnered with fellow Illinois faculty and Mayo Clinic scientists to create a revolutionary cloud-based analytical tool that enables biomedical and clinical researchers to extract knowledge from genomic data. Their Knowledge Engine for Genomics (KnowEnG) tool will be uniquely powerful in its integration of many disparate sources of gene-related data, and its scalable design will be able to accommodate the continued growth of genomic community knowledge.

When it’s complete, researchers will access KnowEnG via an intuitive web-based user interface, through which they can analyze their own gene-based data sets in the context of the entire body of previously published gene-related data (aka the Knowledge Network). Currently, the team is testing KnowEnG’s usefulness and functionality through three projects: pharmacogenomics of breast cancer, identification of gene regulatory modules underlying behavioral patterns, and the genome-based prediction of microorganisms to synthesize novel drugs.

A part of precision medicine, pharmacogenomics is the study of how a person’s unique genetic makeup influences his or her response to medications. So far, Sinha has developed a novel computational method that integrates the public knowledge of gene expression, genotype, and drug response data in diseased cells. His Gene Expression in the Middle (GENMi) tool discovered specific proteins, or transcription factors, that regulate which genes are turned on or off, thus influencing the effectiveness of certain drugs. GENMi is the first technique to assess regulatory associations with drug response.

In another area, Sinha and his colleagues are collaborating with NCSA on developing the computing infrastructure necessary to make their tools widely accessible to biologists and clinicians

through a web-based user-friendly portal, rather than be posted on GitHub or a research group's web site. The back end of KnowENG, which contains the massive body of community knowledge, will reside in the cloud.

## Mining Data to Extract Medical Knowledge

CS Professor ChengXiang Zhai uses his data mining and natural language processing expertise to develop text information systems that enable knowledge discovery from vast amounts of information. "The goal of my research in the health domain is to empower patients or doctors to improve decision making," Zhai said. "We can use advanced technology to reduce medical costs and improve diagnosis and treatments."

One area of health costs and outcomes that Zhai is addressing is side effects of prescribed medication. According to the Food and Drug Administration, adverse drug reactions are the fourth leading cause of death among hospital patients in the United States. And experts estimate that the cost of treating these reactions is nearly \$136 billion.

Zhai and his PhD student Sheng Wang created a novel tool that analyzed patient discussions about drug side effects found on Internet-based health forums. They used advanced data mining techniques to separate the vocabulary so they could automatically identify the drug names and whether the patient was describing disease symptoms or suspected drug side effects.

Their SideEffectPTM software was able to discover the side effect symptoms of many drugs in an unsupervised way—a major improvement over conventional methods, which require a health professional to first annotate or label the mined data so the software can use machine learning techniques to become familiar with the medical terminology.

"Our approach successfully identified side effects for certain drugs," Zhai noted. "We even discovered a few side effects that had not been reported to the FDA yet. In addition, we demonstrated that our analysis method found some drug-drug interactions."



DETECT . . . . . TREAT . . . . . CURE

This research is hoping to assist in medical breakthroughs for **detection, treatment, or even cure** for these human conditions:

MACULAR DEGENERATION

TYPE 2 DIABETES

PARKINSON'S DISEASE

OBESITY

HEART DISORDER

Professor William Gropp



Professor Carl Gunter



Professor Tandy Warnow



In the future, Zhai and his team want to expand their data collection and mining to include hospital patient medical records and patient genomic data rather than just online health forums to discover knowledge about variations of side effects in different genetic groups. Someday, he envisions his techniques being incorporated in a hospital system, where doctors could look for any known or suspected side effects associated with drug interactions for each individual patient before prescribing medicine.

In a separate collaboration with IBM, Zhai analyzed patient medical records to predict the onset of congestive heart failure. Specifically, the team analyzed unstructured text data found in the clinical notes section of the records. By using natural language processing techniques, he could extract useful signals from the notes, especially the mention of symptoms. This discovery of new symptoms could be added to the known symptoms for CHF.

“We showed that these additional symptoms can improve the accuracy of predicting the onset of CHF by 10 percent,” Zhai said. “Before this experiment, there was a predictor for CHF by taking data from the structured fields, not the clinical notes. Our result is a specific example of the general benefit of exploiting Big Data—combining all relevant data to a problem from all sources in a predictive model can often improve prediction accuracy.”

## Ensuring Data Security and Patient Privacy

While the collection and sharing of genomic data have many benefits, they also create potential challenges. According to CS Professor Carl Gunter, genomic Big Data has major personal privacy implications because it's unique and has to have additional safeguards compared to data typically found in electronic

health records, like body temperature, weight, or blood pressure. “Genomic data changes little over a lifetime and may have value that lasts for decades,” he said. “This long-lasting value means that holding and using genomic data over extended periods of time is likely.”

Gunter and his students are developing techniques that guarantee the security and privacy of genomic data while ensuring that biomedical researchers or clinicians have appropriate access to the data. They created the Controlled Functional Encryption (C-FE) tool, which is better than conventional methods like functional encryption or secure two-party communication because it doesn't require any direct interaction between the researcher and the genome donor. In addition, C-FE is more secure and computationally efficient.

The C-FE tool is ideally suited for a situation where a cancer patient's physician wants to search on a nationwide scale for similarly diagnosed patients with similar genetic makeup in the hopes of finding therapies that worked or didn't work. While many schemes have been proposed for this scenario, they are designed to compare two genomes, not hundreds or thousands. Gunter's C-FE scheme is scalable, so it efficiently supports genomic profile comparisons among very large populations, costing between \$140 and \$1,400 depending on the number of genetic variations being sequenced.

In another research project, Gunter and his students created a framework for properly handling genomic data—from understanding security and privacy requirements to designing a threat model that identifies the types of possible attacks at each step in obtaining, storing, and analyzing the data. Gunter's framework deals head on with the issue of re-identification.

One of the most serious forms of attack, re-identification occurs when an unauthorized party tries to recover the identities of donors by looking at the published human genomes.

A successful re-identification attack could seriously harm the donor through potential employment discrimination, denial of life insurance, or inappropriate marketing.

Although genomic repositories have removed obvious personal information like name and date of birth, hackers could still potentially identify individuals. “DNA is intrinsically identifiable, so if a hacker had access to your data, they could infer phenotype information—a person’s observable characteristics like eye, hair, and skin color,” Gunter explained. “There’s a chance they determine the shape of your face, and in the future, they could possibly identify people quickly from DNA data.”

## How New Sequence Alignment Tools Can Impact Precision Medicine

The human microbiome is known to have a huge impact on health. For example, the gut microbiome (i.e., the bacteria living in the intestine) are different between thin and obese people, and can impact whether a person develops Type 2 diabetes, how he or she responds to drugs, etc. No two people have the same microbiomes, so understanding and characterizing human microbiomes has immediate relevance to precision medicine.

The challenge in analyzing microbiomes is that the data consists of millions to billions of short DNA fragments. “We need to be able to look at each fragment, which might only have 100 nucleotides, and figure out what gene and what species it is,” said CS Professor Tandy Warnow. “Fundamentally, the challenge is to be able to place a short fragment inside the Tree of Life. But because the fragment is very short and also has errors (due to sequencing technologies), this is a very challenging problem.”

To address this problem, Warnow and CS Professor William D. Gropp are designing new statistical methods and implementing them for

supercomputers, to ensure that the best accuracy can be obtained with high speed.

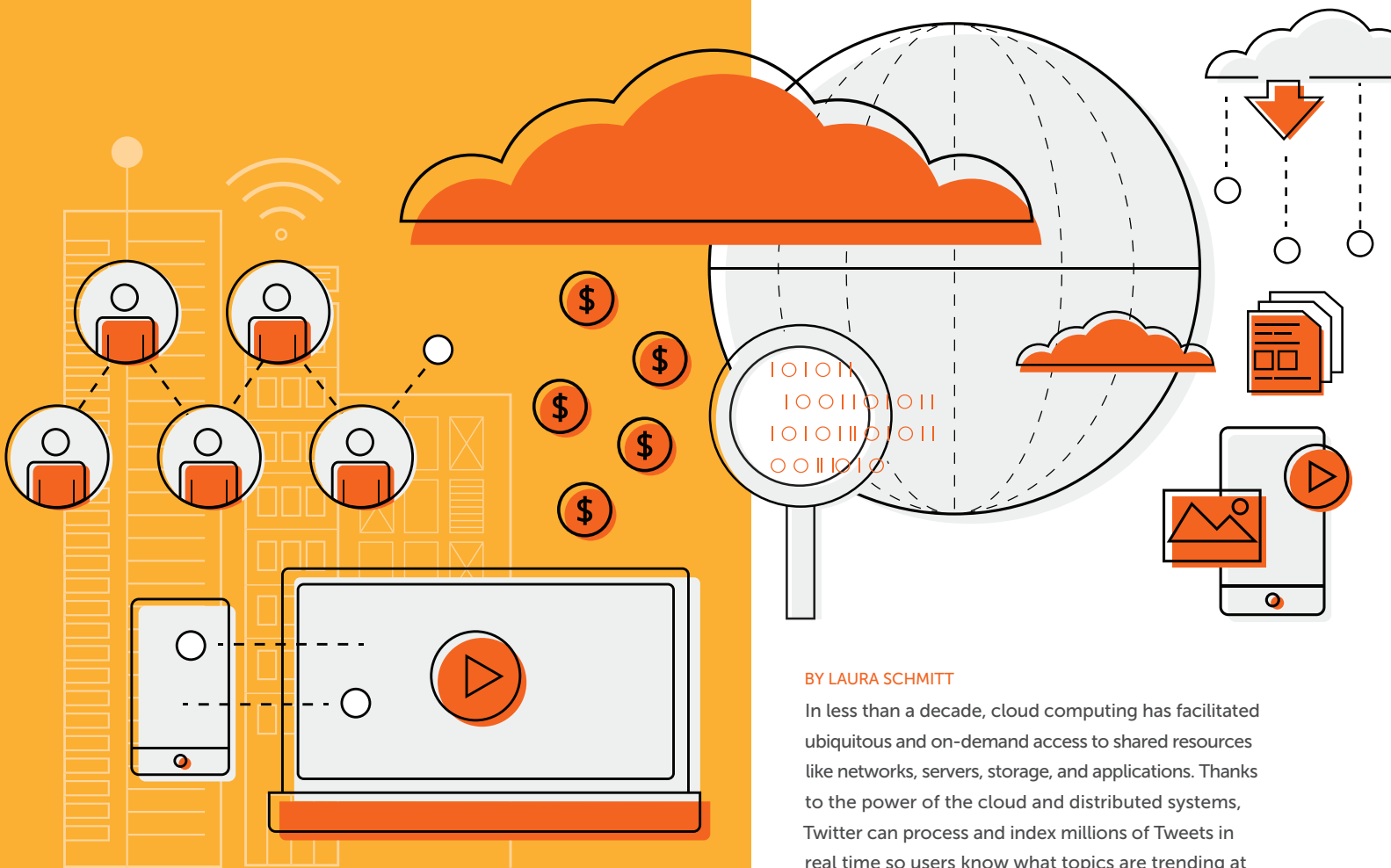
According to Warnow, one of the grand challenges in analyzing microbiome data is the need for new multiple sequence alignment (MSA) software tools that are more accurate and capable of handling larger data sets than conventional methods. Biologists and other researchers use MSA tools to analyze and find similarities in genomic data like DNA, RNA, and proteins, which can have millions of sequences.

These alignments are also used for constructing evolutionary trees, predicting protein structures and functions, understanding how humans migrated across the globe, etc. Thus, multiple sequence alignment methods are not only needed for microbiome analysis, but for many other challenging scientific problems.

However, there’s a catch: in addition to their vast size, the genomic data are sometimes fragmented or incomplete, which makes it very difficult to construct an accurate alignment. “There’s this whole cascade of inferences that begins with accurate multiple sequence alignments—errors here have consequences downstream,” explained Warnow. “What was happening was people were giving up on their data, thinking it was too big or too heterogeneous to be analyzed accurately.”

Warnow has developed a set of new MSA tools that can accurately and quickly align large sequence datasets. An international team of researchers used Warnow’s alignment method PASTA to align the DNA of 1,200 plant species and 13,000 gene families as part of the One Thousand Plant Transcription Project (1kP), which revealed new knowledge about the evolution of plant life on Earth and identified new algae proteins in the sequence data that may someday even have applications in medicine.

“We give biologists and researchers better methods, allowing them to get good accuracy quickly,” said Warnow. “Therefore they get better biological discoveries downstream.”



# Illinois researchers advancing cloud technology

Microsoft-funded center making cloud more reliable, efficient & cost effective

BY LAURA SCHMITT

In less than a decade, cloud computing has facilitated ubiquitous and on-demand access to shared resources like networks, servers, storage, and applications. Thanks to the power of the cloud and distributed systems, Twitter can process and index millions of Tweets in real time so users know what topics are trending at any moment, Facebook can sift through data to show relationships and similar interests among its more than 1 billion users, and Google or Bing can return quick and relevant results for millions of daily search engine queries.



Gopal Kakivaya

As pervasive and commercialized as cloud computing has become, it remains technologically challenging. "At the end of the day, cloud computing is distributed systems," said Microsoft Corporate

Vice President Gopal Kakivaya, who leads Azure, the company's cloud computing platform and infrastructure business. "And distributed computing still has fundamental problems for which pragmatic solutions need to be developed."



Professor Indranil Gupta

An expert in such systems, CS Professor Indranil Gupta, agrees. "Cloud computing has a lot of cool, interesting research problems that are



of particular interest to industry right now,” said Gupta. “Industry wants to know how to scale, ensure fault tolerance, and have the capability of scaling out or in depending on the work load.”

To address these issues, Microsoft Azure established a \$300,000 research center in CS @ ILLINOIS earlier this year—one of only 3 such centers nationwide. The Blue & Orange Cloud Computing Center (BOCCE) is developing new algorithms, techniques and systems designs while at the same time enhancing industry’s popular open-source software in an effort to make cloud computing more efficient, reliable, and cost effective.

BOCCE research already is paying dividends in the area of distributed graph processing, which companies rely on extensively, from social networking firms, who use it to provide recommendations and mine the network, to web search firms, who use it to calculate PageRank. The sheer scale of these graphs, which may have over a billion vertices, drives the need to use a distributed cluster of servers to process them quickly.

Today’s distributed graph processing frameworks operate in such a way that once the computation starts there is no way to add more machines (aka scale out) to speed up computation, without shutting down and restarting the job. Nor is there a way to operate on fewer machines (aka scale in) to reduce computation costs. The ability to scale out/in is critical for system administrators to be able to have their job complete faster, or to reduce the cost it is incurring in a public cloud.

Working in collaboration with CS Professor Roy Campbell, Gupta’s group developed novel techniques to enable on-demand elasticity operations in distributed graph processing engines.

Their techniques can add or remove machines without interrupting the ongoing job computation, while only marginally slowing down the overall job completion time. Mayank Pundir and Luke Leslie, Gupta’s students, won the Best Paper Award for this work at the IEEE International Conference on Cloud Engineering in 2016.



Professor Roy Campbell

Two of Gupta’s other students, Le Xu and Faria Kalim, have built a system that scales out/in the popular distributed stream processing system Apache Storm, which companies like Twitter, LinkedIn, and Uber use to process streams of data in real time. “The ability to scale out/in without shutting down computation is critical here,” said Gupta, whose students accomplished this with minimal overhead.

In a third cloud-related project, CS Professor and Coordinated Science Laboratory Director Klara Nahrstedt is developing a multi-camera, tele-health technology that will enable patients and medical personnel to record and stream their health sessions via the cloud. The system her group is creating will be capable of analyzing and summarizing hours of patient-related videos, which a doctor could search and view in order to assess and answer health-related questions. The summary video could then be attached to a patient’s electronic health record.



Klara Nahrstedt

“The biggest challenge we’re addressing is creating a data architecture to compress, organize, store, and analyze this huge amount of data, which is bigger than what personal computers can store now,” said Nahrstedt, who will use the Azure platform to stream data to the cloud. “We also want to make sure the video can be distributed and viewed on mobile devices.”

Ultimately, Nahrstedt envisions a tele-health service system simple enough to be installed either in patients’ homes for tele-physiotherapy using laptop cameras and motion sensing from Kinect, or in an emergency medical system environment using body cameras on health-care workers responding to a 911 call. The health-care system or hospital would install the Azure cloud platform to securely store, summarize, and compress the videos.

Well into BOCCE’s first year, Gupta is pleased with the progress on these and other projects. “We’re building cutting edge systems from scratch that significantly outperform existing systems in scalability, reliability, and performance,” said Gupta. “The problems we address are directly relevant to systems that are widely used in industry, especially open-source software.”

# Gravitational Waves: A CS @ ILLINOIS Connection

BY TOM MOONE

In February, the National Science Foundation released the astounding news that scientists had, for the first time, “observed ripples in the fabric of spacetime called gravitational waves, arriving at Earth from a cataclysmic event in the distant universe.”

The import of this observation is vast. It confirms a major hypothesis of Albert Einstein’s 1915 general theory of relativity, the theory that underpins the modern understanding of the universe. Part of Einstein’s theory predicts that two black holes colliding would create waves of gravitational radiation (gravitational waves). However, detecting these waves on Earth would be extremely difficult because these waves would be extremely small. Ed Seidel, director of the National Center for Supercomputing Applications (NCSA), explained, “Einstein himself did not believe that those waves could ever be detected, if they were even real.”

“Einstein himself did not believe that those waves could ever be detected, if they were even real.”

The detection of these waves by the Laser Interferometer Gravitational-wave Observatory (LIGO) was the culmination of a century of effort by scientists to find evidence that would support Einstein’s equations that stem from his theory of general relativity. And part of that history took place at the University of Illinois.

In the early 1990s, Seidel was a research scientist at NCSA whose work focused on the problem of solving Einstein’s equations,



Ed Seidel, director of NCSA

specifically looking at the black hole and gravitational wave problems presented in those equations. Soon after he arrived, he met CS Professor (now Professor Emeritus) Paul Saylor, whose own research examined how mathematics related to the physical sciences, particularly focusing on partial differential equations and linear algebra. They quickly hit it off and started collaborating on the problem of solving Einstein’s equations.



Professor Paul Saylor

One of Saylor’s graduate students, Steven Lee (PhD CS ‘93), was doing his doctoral research on developing equations that were able to conserve certain constraints, such as conservation of mass or of momentum. This work dovetailed nicely with the physics work that Seidel was doing at NCSA. Together with Saylor, Lee met regularly with Seidel’s NCSA team to develop approaches to solving the Einstein equations.



Steven Lee (PhD CS '93)

“I worked with Ed’s team on some test problems that they already were starting to have some challenges with and to apply the software that I was developing for my PhD thesis,” said Lee. “It was Steve who probably gave Ed the most computational help, because this was his application problem for a PhD



in computer science,” Saylor said. “The rest of us tried to make sense out of what Steve was coming up with, which included some of the most elegant algebraic relations I’ve had the good fortune to enjoy.”

Although Saylor would describe his impact on these research endeavors modestly—saying his role ranged “from not too significant to very insignificant”—others would disagree. Seidel said the work Saylor had been doing was important to his research efforts. “Many of the techniques that Paul had developed around linear systems and solving elliptic equations and so on are the kinds of equations that show up in Einstein’s equations,” said Seidel.

“I believe that Paul was instrumental in terms of connecting the dots [for] getting the top computational scientists interested in this problem,” said Lee, noting that these connections developed important interactions across science fields. “It was a new degree of collaborating between mathematicians and computer scientists and physicists—people who were studying general relativity.”

The work done at Illinois in the 1990s was early work. These researchers knew that the technology they were dealing with was not yet ready at that time to make the discovery that occurred in February. “This was very much blue sky research,” Lee said. “You didn’t have these gravitational wave reports yet, but we started doing the groundwork on the mathematics and the computational software needed for preliminary studies of what signals we might expect to detect [in the future].”

“There are now more sophisticated methods,” Seidel explained. “I don’t want to say that they are using the methods that we developed. But we did do—in collaboration with Paul—the first three-dimensional collisions of black holes and wave forms from them. Those were stepping stones along the way. Now there are more modern methods that do an even better job than we could do when we were doing this.”

For more details visit: <https://cs.illinois.edu/news/gravitational-waves-illinois-connection>



## Interdisciplinary Team Receives Turner Innovation Award

A collaboration between the University of Illinois and Turner Construction—the largest builder in the U.S.—has earned the distinction of “Most Innovative Idea” in Turner’s Fourth Annual Award for Innovation program.

Civil & Environmental Engineering Professor Mani Golparvar-Fard the lead principal investigator on the Illinois project, collaborating with CS Associate Professor Derek Hoiem and Aerospace Engineering Associate Professor Tim Bretl. CS graduate students Joseph Degol, Rajbir Kataria, and Ka Wai Tsoi are also contributors.

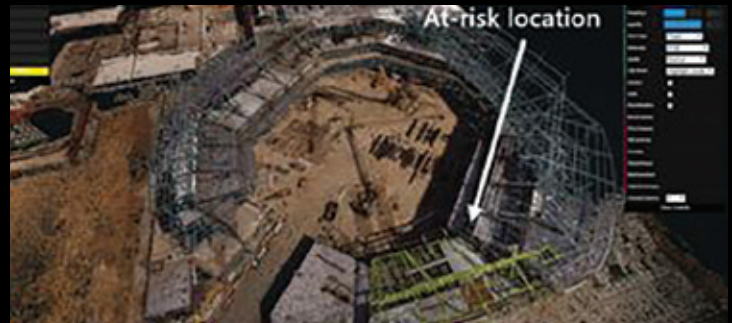
The Illinois team has developed predictive visual data analytics tools, called “Flying Superintendent,” to automate and streamline today’s time-consuming practices for construction progress monitoring.

Their Turner Innovation Award-winning solution utilizes both images and videos taken with camera drones and four-dimensional Building Information Modeling to quickly identify and visually communicate the actual and potential performance problems during execution of construction projects via smartphones and tablets to project participants, on and off site.

Turner implemented the technology as a pilot project at the construction site of the new arena for the NBA’s Sacramento Kings. The Illinois work is funded by a nearly \$1 million Cyber-Physical Systems grant through the National Science Foundation. The team is commercializing their solution via RECONSTRUCT Inc., a new spinoff company housed in University of Illinois Research Park.



Professor Derek Hoiem



For more details, visit <http://cs.illinois.edu/news/interdisciplinary-team-receives-turner-innovation-award>



## Bensal Named a Knight of St. Patrick

CS senior Jay Bensal was honored as a 2016 Knight of St. Patrick, a College of Engineering distinction that recognizes leadership, excellence in character, and exceptional contributions to the college and its students.

One of the early members of Founders, a registered student organization focusing on entrepreneurship, Bensal took the lead in organizing the first iteration of 54, a high-energy startup event, where students of all majors team up to bring their business ideas to life over the course of 2-1/2 days. Several of the teams that have participated in 54 have gone on to win cash prizes at campus entrepreneurial competitions.

In addition, Bensal has helped lead the Founders Startup Career Fair, bringing together engineering students with startup companies from across the country.

Co-sponsored with ACM in the fall and Engineering Career Services in the spring, the event has reached thousands of students and over a hundred companies in its four semesters on campus.



"The work I've done with Founders definitely wouldn't be possible without the efforts of the other students on the team," Bensal said. "We try to cultivate a fast-paced, collaborative environment that people want to be a part of."

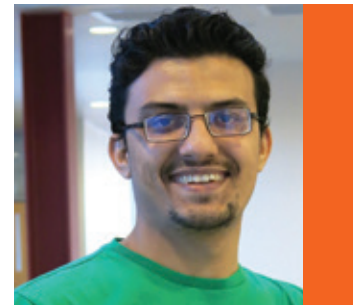
## Naveed wins Ross J. Martin Award

CS PhD student Muhammad Naveed has been named the winner of the 2016 Ross J. Martin Award by the College of Engineering. Given to only one graduate student across the College each year, the award recognizes outstanding research achievement.

Naveed, who is advised by Professors Carl A. Gunter and Manoj Prabhakaran, brings tools and ideas from theoretical cryptography to bear on practical problems in cyber-security and information privacy. His research explores fundamental security flaws in popular systems, while developing practical—yet provably secure—cryptographic systems for real applications.

He has created systems for the secure outsourcing of genomic data and developed searchable encryption systems to work on real cloud storage services. Naveed has also studied security flaws present in popular property-preserving encrypted database systems such

as CryptDB, Google Encrypted BigQuery, and Microsoft SQL Server, with results covered by the popular press. With colleagues from Indiana University, he identified flaws in the Android device driver customization process; as a result, over 50 million newer phones do not have those flaws.



Naveed is a previous recipient of the Google PhD Fellowship in Security, the Sohaib and Sara Abbasi Fellowship, the C.W. Gear Outstanding Graduate Student Award, and a best paper at CSAW 2014. He will join the University of Southern California as an Assistant Professor of Computer Science.

# HackIllinois: One of the Best Collegiate Hackathons in the Country



Thirty-six hours, 1,525 young people, 59 corporate sponsors, and dozens of clever technology ideas—welcome to HackIllinois 2016, where the nation's top students convene on the University of Illinois campus to create mobile apps, websites, or hardware in a fast-paced, caffeine-fueled, fun weekend. Held this year on February 19–21 at Siebel Center and the ECE Building, HackIllinois is among the largest and best run student hack competitions in the country.

"We're really focused on doing things right, whereas other places are interested in maximizing the number of participants," said CS junior Nick Kortendick, who was co-chair of last year's event and helped execute this year's hack. "We don't scale unless we know we can do it. We want it to be a positive experience."

According to HackIllinois co-chair and CS senior Rohan Kapoor, the 2016 event

doubled the number of participants from its inaugural 2014 hackathon. "We are thrilled with how it went," he said moments after the closing ceremony and awards were presented for best hardware and software projects.

One of those projects involved integrating the popular Mario Kart video game with a real car's mechanical and software systems. The Catch Me if You Can team, which won first place in the hardware category, included Illinois physics undergraduate J.P. Smith and two students from Illinois State University.

"With the car parked, we used my steering wheel, accelerator, and brakes to play MarioKart," said Smith, noting the campus police stopped by to check what they were doing early Sunday morning. "The police were really nice about it, but they were like, 'Really, what are you doing in the parking garage at 2 a.m. with all the lights on?'"

Run entirely by students, HackIllinois is popular among corporate recruiters who come to help the participants with their projects while looking for talented future employees.

"We can see what people can make in a whole weekend, as opposed to learning about them in an hour interview," said Matt Kula, a software engineer with Facebook. "We can see how creative they are, how quickly they learn, and what they can produce in a limited amount of time. We can also be mentors and help the students solve problems."

Kapoor and fellow CS undergraduate Sri Vasamsetti led a team of 150 volunteers on planning and executing the event, which also included fun diversions like drone racing, a Nerf gun battle, and a tour of the Blue Waters supercomputer facility.



“We can see how creative they are, how quickly they learn, and what they can produce in a limited amount of time.”

—Facebook Software Engineer Matt Kula



# Celebration of Excellence Faculty & Student Awards



Each semester, CS @ ILLINOIS honors students and faculty who have received important distinctions. We extend congratulations to these individuals whose hard work is a credit to themselves and a source of pride for the department.

## JP Morgan Chase WCS Scholarship

JP Morgan Chase, a leading global financial services firm, has generously supported eight CS @ ILLINOIS students since 2014 with its Women in Computer Science Scholarship. With annual investment of over \$9 billion in technology and a staff of 40,000+ technologists, technology and innovation is critical to delivering for over 40 million customers, and managing over \$2.4 trillion in assets.

## Graduate Fellowships & Awards

ANDREW AND SHANA LAURSEN FELLOWSHIP  
Vera Liao

C. L. AND JANE W.-S. LIU AWARD  
Sheng Wang

C. W. GEAR OUTSTANDING  
GRADUATE STUDENT AWARD  
Xiang Ren

CS @ ILLINOIS OUTSTANDING  
TEACHING ASSISTANT AWARD  
Tana Wattanawaroon

FENG CHEN MEMORIAL AWARD  
Amirhossein Aleyasen  
Md Tanvir Al Amin  
Motahhare Eslami  
Muhammad Huzaifa  
Maria Kotsifakou  
Shen Li  
Muhammad Naveed  
Muntasir Raihan Rahman  
Matthew Sinclair  
Prakalp Srivastava  
Kristen Vaccaro  
Shiguang Wang

FENG CHEN MEMORIAL AWARD IN  
SOFTWARE ENGINEERING  
Cosmin Radoi

FIFTY FOR THE FUTURE  
Wing Lam

GRADUATE STUDENT OUTSTANDING  
AMBASSADOR AWARD  
Imani Palmer  
P. Daphne Tsatsoulis

GRADUATE STUDENT OUTSTANDING  
SERVICE AWARD  
Faraz Faghri

MAVIS FUTURE FACULTY FELLOW

Faraz Faghri  
Raghavendra Pothukuchi  
Jason Rock  
Matthew Sinclair

OUTSTANDING TEACHING ASSISTANT, FALL 2015  
Chaitanya Datye  
Erin Carrier  
Edward Karrels  
Minje Kim  
Shardul Natu

RICHARD T. CHENG ENDOWED FELLOWSHIP  
Xiang Ren

ROSS J. MARTIN AWARD  
Muhammad Naveed

## Undergraduate Scholarships & Awards

C. W. GEAR OUTSTANDING  
UNDERGRADUATE AWARD  
Mark Miller  
Xun Lao

CRA OUTSTANDING UNDERGRADUATE  
RESEARCHER AWARD, HONORABLE MENTION  
Andrey Zaytsev

CROWE HORWATH LLP OUTSTANDING JUNIOR  
COMPUTER SCIENCE SCHOLARSHIP  
Sujay Khandekar  
Brianna Ifft

DANIEL L. SLOTNICK SCHOLARSHIP  
Han Chen

DUNCAN H. LAWRIE STUDENT LEADERSHIP AWARD  
Jay Bensal

FENG CHEN MEMORIAL AWARD  
Andy Vuong

## 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](mailto: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. For more information about giving opportunities, visit: <http://cs.illinois.edu/give>.



FRANZ HOHN AND J. P. NASH SCHOLARSHIP  
Tingting Cai

ICCP JAMES N. SNYDER MEMORIAL AWARD  
Hyunbin Park

JAMES N. SNYDER AWARD FOR  
SCHOLASTIC ACHIEVEMENT  
Brian Griffin  
Paige Kordas

JEFFREY P. BLAHUT MEMORIAL SCHOLARSHIP  
Andrey Zaytsev

JOHN R. PASTA AWARD  
Tong Li  
Chris Mathew

JP MORGAN CHASE WCS SCHOLARSHIP  
Manasa Sanka  
Renee Tso

KNIGHT OF ST. PATRICK  
Jay Bensal

SENIOR 100 HONORARY  
Avi Prasad

SPOT TRADING SCHOLARSHIP  
Emily Chao

ASE MOST INFLUENTIAL PAPER AWARD  
Darko Marinov

CAMPUS AWARD FOR EXCELLENCE IN  
GRADUATE STUDENT MENTORING  
ChengXiang Zhai

CAMPUS AWARD FOR EXCELLENCE  
IN UNDERGRADUATE ADVISING  
Steve Herzog

CRA BOARD OF DIRECTORS  
Josep Torrellas

DEAN'S AWARD FOR EXCELLENCE IN RESEARCH  
Paris Smaragdis

EDUCATION INNOVATION FELLOW  
Brian Bailey  
Luke Olson

ICDT TEST OF TIME AWARD  
Chandra Chekuri

IEEE SIMON RAMO MEDAL  
Lui Sha

NCSA FACULTY FELLOW  
Karrie Karahalios

SLOAN RESEARCH FELLOWSHIP  
Jian Peng

TURNER INNOVATION AWARD  
Derek Hoiem

UNIVERSITY SCHOLAR  
Vikram Adve

USENIX NSDI TEST OF TIME AWARD  
Matthew Caesar

## Faculty & Staff Awards

10 WOMEN YOU SHOULD KNOW IN  
NETWORKING AND COMMUNICATIONS  
Klara Nahrstedt

ACM DISTINGUISHED SCIENTIST  
Tao Xie

ACM FELLOW  
Tandy Warnow

ACM SIGCOMM RISING STAR AWARD  
Brighten Godfrey



**RENEE TSO** (class of 2018)

enjoys teaching computer science to middle and high school students. She has interned with Girls Who Code, as well as Google and Qualcomm, and she has served as a course assistant for CS 125.



**MANASA SANKA** (class of 2017),

who has served as Tech Chair for the Society of Women Engineers and Alumni Chair for Women in CS, likes to involve girls in engineering. She has interned for Salesforce and Zeta Interactive.

# Google's Corporate Match Boosts Poloney's Gift

BY LAURA SCHMITT



When Joel Poloney (attended 2004–2007) left the University of Illinois to start gaming company MyMiniLife Inc. with three

classmates, he had some major student loan debt—accumulated from paying out-of-state tuition rates that were three times what in-state students paid. “I knew U of I CS was the perfect place for me and was happy to take on that financial burden,” Poloney said. “I struggled to make ends meet at first... but it all worked out in the end.”

Today, Poloney is a member of Google’s Firebase team, where he leads the development of several products that enable mobile developers to quickly create high-quality apps and grow their user base. He proudly stays engaged with his alma mater by attending CS @ ILLINOIS alumni events in the Bay Area and working with student groups like ACM.

Poloney has also returned to campus as an Entrepreneur in Residence (EIR), sharing his expertise and career successes with students, which include co-creating FarmVille and founding mobile marketing company Red Hot Labs with Amitt Mahajan (BS CS ’06).

By taking advantage of Google’s Company Match Program, he has directed \$10,000 toward two departmental priorities to help students—the Engineering Visionary Scholarship Initiative (EVS) and the CS Annual Fund. EVS helps current students

afford their CS education through large, renewable scholarships. “There are so many students who would not otherwise have access to an Illinois education,” said Poloney. “I really want to bring the best students to Illinois regardless of their financial situation.”

Poloney’s gift also supports CS @ ILLINOIS engagement activities and events that inform alumni about faculty and student achievements, provide networking opportunities, and demonstrate the impact of philanthropic support. “I absolutely love the University of Illinois and I really believe we have a world-class computer science program,” he said. “I was very fortunate to have experienced it and owe a great deal of my success to the education I received and the friendships I made while in school.”

Throughout his career, Poloney has always found Illinois graduates to be really smart, technically solid project team members, so he encourages his fellow alumni to join in helping current students receive the gift of an Illinois education.

“By donating, you’re investing in your own future, as well as a student’s future,” Poloney said. “You will surely work with many CS @ ILLINOIS alumni—keeping the talent pipeline strong will benefit you, your company, and our industry.”

**Double or even triple your impact.**

See if your company has a matching gift program.

For more information visit:  
<http://bit.ly/2dbGpk1>



## Senior Projects Course Helps Students Transition from Pupils to Problem Solvers

Each fall, CS Lecturer Michael Woodley welcomes a new group of students to the 2-semester senior projects course (CS 492-94). He invites the students to apply to work on projects with corporate clients, or he matches them with projects for clients in the non-profit sector. Either way, the students begin one of the most challenging yet valuable classes in their undergraduate career.

According to Woodley, in eight short months, the students will apply years of knowledge to solving a real-world problem. In the process, they will have learned how to: work with colleagues—a typical project has four students—define a problem, develop and test a solution, and communicate their progress to their client.

“Students have to deal with things that are not well defined,” said Woodley, who serves as the course coordinator. “That’s a difficult transition because up until now they are used to knowing there’s a best answer to problems from their course work. In senior projects, they know something has to get done, but they need to figure out how to organize it, how to do it, then get it done.”

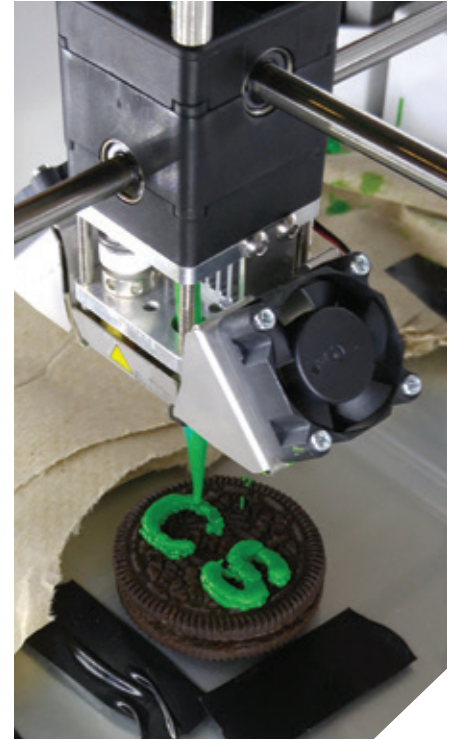
This past spring, more than 140 students completed 30+ projects—the most ever in the course’s 14-year history. In April, they presented their research results to clients, faculty, and fellow students at the Senior Projects Showcase in Siebel Center. One of those projects, SugarCUB3D, taught children introductory programming concepts and then rewarded them by 3D printing their initials with icing on an Oreo cookie.

According to CS senior David Naber, who worked on SugarCUB3D, the big takeaway from the course was to start the design process early and understand what the client really wanted. “The hardest part was distilling [the client’s] goals for the project into actionable things we could work on,” Naber said.

Other memorable projects over the years include real-time facial recognition and memory software for Rockwell Collins, a mobile app that enabled cancer patients undergoing treatment to easily schedule help from their friends with meals and other tasks, and geographic information technology that converts map data into games.

Woodley encourages companies to consider sponsoring one or more projects, especially since students interested in working for a corporate client submit their resumes as part of the matching process at the start of the course. “It’s a way for companies to recruit,” Woodley noted. “Not everyone will work for Twitter or Google, so [with] a variety of projects students can discover other applications of computer science that they didn’t know existed.”

In the spring 2017 semester, Woodley will offer a similar projects course for juniors, which will benefit both the students and the clients. “The students would finish their project halfway through their senior year,” said Woodley, noting that this project-based experience could help them land a job. “The companies will benefit because they’ll meet the students earlier in their academic career.”



### Interested in sponsoring a CS 492/4 course senior project?

- Contact Mike Woodley at [mwoodley@illinois.edu](mailto:mwoodley@illinois.edu).
- Cost is \$12,000.
- Course runs from late August until mid-April.
- Company representatives pitch their projects to all the enrolled students at the start of the fall semester. After reviewing student resumes, company reps can help select students for their project.

For more information visit:  
<http://bit.ly/2d0ZH2K>



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## Keep in touch and get involved!

We want to stay connected with our alumni and friends. Visit [www.cs.illinois.edu/alumni](http://www.cs.illinois.edu/alumni) on the redesigned CS Website to learn more and get links to update your contact information, take our alumni survey, schedule a campus visit, reconnect with student groups, explore continuing education options, become a corporate partner, or make a gift to support current students.

**BELOW: CS Department Head Rob A. Rutenbar welcomes the fall 2016 CS freshman class. A record 46% of CS-Engineering freshmen are female.**



[cs.illinois.edu](http://cs.illinois.edu)