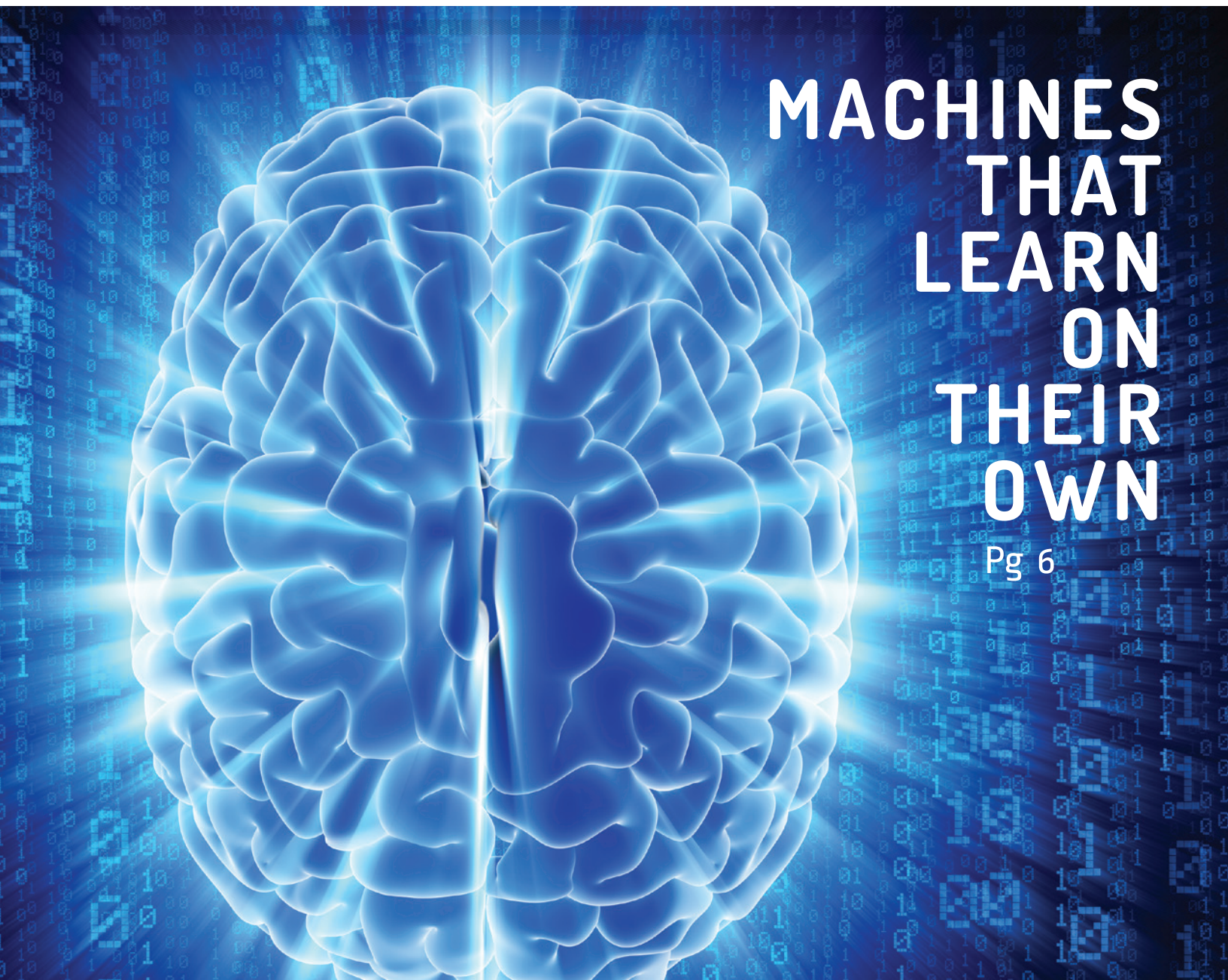


# :CONNECT



## MACHINES THAT LEARN ON THEIR OWN

Pg 6

# :CONTENTS

## News Briefs

Pg 4

## COVER STORY: Machines That Learn on Their Own

Pg 6

## Aerial Imaging Technology Provides Diagnostic Tool for Agriculture

Pg 10

## Quick Look: Congratulations to CSL Researchers

Pg 12

## Arjun Athreya Investigates Biological Markers of Disease

Pg 13

## Events

Pg 14

## Q & A with Normand Paquin

Pg 15

# :CONNECT

SPRING 2017

## COORDINATED SCIENCE LAB

College of Engineering  
University of Illinois at  
Urbana-Champaign

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

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## A MESSAGE FROM OUR DIRECTOR

As we close out a fantastic 2016—in which CSL marked its 65th anniversary and the launch of two new NSF centers—I wanted to take a moment to celebrate some of the accomplishments that may have flown under the radar, so to speak.

Several years ago, CSL made the decision to invest more resources into our students. We recognized that when students thrive, CSL thrives. As a result, we launched several initiatives that have grown into activities that are helping students connect with each other, are spurring new ideas, and are better preparing students for their futures.

Those initiatives include:

**PhD Thesis Award**—In 2016, we selected our first CSL PhD Thesis Award winner. The award was established to honor a student researcher whose PhD thesis made advances in a disciplinary area with interdisciplinary impact. Our inaugural winner was **Seyed Rasoul Etesami**, who made contributions in the effort to exploit the connections among evolutionary behaviors in social, communication, and distributed networks using the availability of large amounts of data generated by these systems. Seyed, whose advisor was **Tamer Başar**, was honored for his efforts in a ceremony on Oct. 14.

**Social Hour**—Now in its second year, the Social Hour event has become a true center of student social activities. This semester, three groups—Decision and Control; Signals, Inference, and Networks; and Circuits—provided significant support to the Social Hour. Highlights of the past semester include presentations by **Naresh Shanbhag** on SONIC and **Tim Bretl** on his educational work with inmates. In addition, we've had great participation in the Video

of the Month contest, in which students are asked to showcase their research via video, with entries highlighting everything from UAVs to computer vision technologies.

**CSL Student Conference**—The CSL Student Conference has developed into one of the best-run student events in the College of Engineering. Following a banner 2016 event, which drew a record-breaking 450 registrants, students are now actively planning the 2017 conference in February. I could not be more impressed with nor proud of this event, which is entirely produced and promoted by our students.

In 2017, we will continue to make student activities a focus of our efforts. In January, we sponsored the Graduate Society of Women Engineers' one-day conference, weSTEM, in support of our female engineering and computer science students. We're also actively seeking nominations for the 2017 CSL PhD Thesis Award winners.

We welcome your ideas on how to continue to grow a vibrant student community at CSL. Please email me directly at [klara@illinois.edu](mailto:klara@illinois.edu) or send your suggestions to [wow@csl.illinois.edu](mailto:wow@csl.illinois.edu). We look forward to hearing your ideas!

**KLARA NAHRSTEDT**

## :NEWS BRIEFS



### IMPROVING WIND TURBINE EFFICIENCY

Volatile behavior—such as wind variances that affect the performance of a network of wind turbines—inspired a team of CSL researchers to investigate the ways systems communicate and collaborate with one other in the face of adversarial conditions. The team, led by CSL Professor **Carolyn Beck**, and former CSL faculty **Angelia Nedich** and **Alex Olshevsky**, received a \$500,000 grant from NSF to create a method that allows each unit of a team to perform well individually, despite unstable conditions, while maximizing output as a group.



### LES ALLEN AT BLACKFEET SUMMER CAMP

CSL Professor **Les Allen** and several students took part in the third annual summer camp at Blackfeet Community College, located on the Blackfeet reservation in Browning, Montana.

The week-long camp gave high school and middle school students a chance to experience campus. Allen and his team introduced students to hands-on solar and wind energy projects that students could keep, including small wind turbines, solar lanterns, and USB iPhone chargers.



### ADSC URBAN NOISE POLLUTION MAPPING

Researchers have been seeking ways to understand and combat the rising levels of urban noise, which can cause health problems such as hearing loss, hypertension, and more. A team at the Advanced Digital Sciences Center (ADSC) developed a signal processing technique that measures urban noise through portable microphones secured to the top of a moving vehicle, enabling the creation of a wide-ranging map of noise pollution.

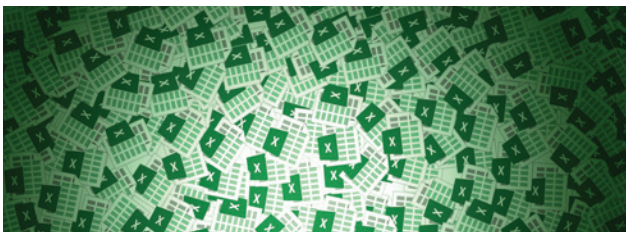
## :NEWS BRIEFS



## RITHMIO TECH AT PARALYMPICS

This past summer, at the Paralympic Games in Rio, the U.S. wheelchair racing athletes competed with a training advantage, thanks to a new app developed by an Illinois start-up company.

The wheelchair athletes used an Android Wear smartwatch application that measures their stroke cadence, helping them better understand their stroke efficiency. Cadence Counter was developed by Chicago-based Rithmio, which was co-founded by Illinois alumnus **Adam Tilton** and CSL and mechanical science and engineering faculty member **Prashant Mehta**.



## NSF BIGDATA GRANT FOR DATASPREAD

In today's era of big data, spreadsheets are no longer able to satisfy user needs—they are beginning to reach their effective limits when dealing with large amounts of data.

To address this issue, **Aditya Parameswaran**, **Kevin Chang** and CSL faculty member **Karrie Karahalios** recently landed a prestigious NSF BIGDATA grant—\$1.8 million over four years—to develop DataSpread, a system that holistically unifies spreadsheets and database systems.

MAX RAGINSKY  
INVESTIGATES  
BELIEF SPACE

CSL Assistant Professor **Maxim Raginsky** received a \$75,000 grant from NSF to investigate methods that process information in the space of beliefs. Many types of decisions are stated in the form

of beliefs: weather forecasts, financial projections, medical diagnostics, and more. Raginsky and his team plan to find techniques that make the process faster and perform with better accuracy, and with fewer resources [such as time, energy, or memory].

ROBUST AND SECURE MANUFACTURING  
SYSTEMS

Spotting a glitch on the factory floor in real time—and reconfiguring around it—are the goals of a new \$4 million multi-university team, including ITI's **Sibin Mohan** and CSL's **Sayan Mitra**.

The project aims to increase factory productivity and American competitiveness. Made possible by a grant from NSF, it will yield “a revolutionary methodology for controlling manufacturing systems,” the researchers say. They call the methodology “software-defined control.”



## :MACHINES THAT LEARN ON THEIR OWN

In the future, Siri will deliver more than a few rote answers when you pose a question to your iPhone. Advertisers will mine social networks and other online sources to better target marketing campaigns. And doctors will more easily detect markers for disease and predict treatments for best outcomes.

All of these will be possible because of machine learning. At the highest level, machine learning is the mathematical foundation that enables machines to “learn” without being explicitly programmed. The discipline, which has its early roots in separate work done by Alan Turing, Arthur Samuel, and Frank Rosenblatt in the 1950s, is helping to fuel new breakthroughs in everything from nanoscale computing to computational genomics to weather prediction.

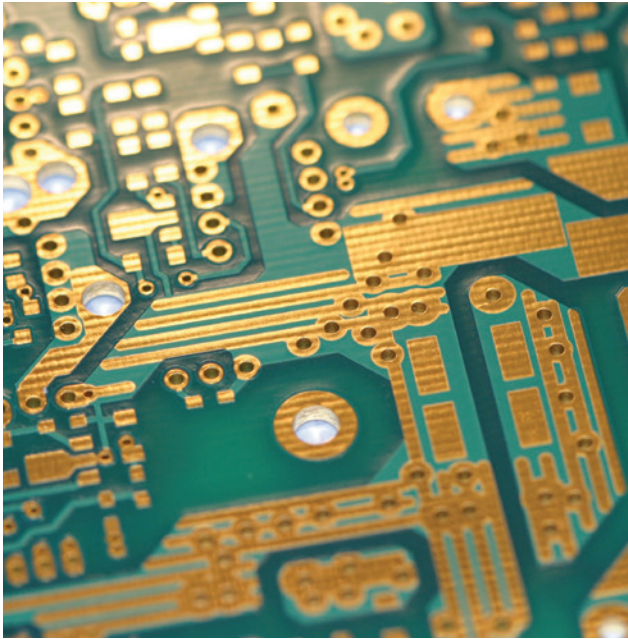
CSL research is helping pave the way. More than 20 CSL researchers are currently working in this space, advancing both the theory of machine learning and emerging applications. Read on to learn more about a few of them.

### CAEML

The new Center for Advanced Electronics in Machine Learning, led by CSL and electrical and computer engineering professor Elyse Rosenbaum, focuses on advances in integrated circuits, or chips, which power everything from smart watches to supercomputers.

CAEML leverages machine-learning techniques to develop new ways to increase performance while reducing chip size and development cost, tapping into a need of the semiconductor industry, one of America’s top exporters.

Currently, chip manufacturers struggle to optimize power, performance, reliability, and cost in their designs, because analyzing the mix is too computationally intensive to execute in a timely manner. Researchers aim to overcome current limitations by employing behavioral models, which look at the behavior, or output, of a chip instead of the internal processes described by physical models [which are the most commonly used kind in today’s design flows].



CAEML researchers Maxim Raginsky and Jose Schutt-Aine use machine learning to advance research in modeling. Raginsky argues that machine learning has the potential to tackle the growing complexity and design constraints of microelectronic circuits and systems by automating the behavioral model generation and providing rigorous guarantees of model accuracy and confidence.

In collaboration with Dean of the College of Engineering Andreas Cangellaris, they plan to develop a machine learning framework for data-driven behavioral modeling of complex microelectronic systems in the presence of uncertainty, noise, and errors.

“The principled use of machine learning, in particular when it comes to efficient use and re-use of data and expert knowledge, will improve design quality and performance, while reducing the time-to-market,” said Raginsky.

Schutt-Aine, along with Madhavan Swaminathan [Georgia Tech] and Paul Franzon [North Carolina State], will use machine learning to develop software for the automated behavioral models of drivers, receivers, and other complex circuits. Their research will draw on neural networks and X parameters to create models that are more accurate and compatible with existing tools.

## WHAT IS MACHINE LEARNING?

Machine learning is the overarching term used to describe the ability of machines to learn. Today, it generally refers to approaches for classification, quantification, organization, and prediction that use very large, unstructured data sets.

But among specific technical communities, the precise nature of “machine learning” research varies widely, says CSL Professor Andy Singer, who has worked in this space for more than 20 years. Depending on whether your field is computer science, control, informatics, signal processing, or another discipline, machine learning could refer to:

- Pattern recognition or the ability to properly label items drawn from large data sets, either with training or automatically from unlabeled data.
- Predicting or forecasting for large structured and unstructured data sets, such as for weather, financial markets, or political elections, or other commercial data.
- Using adaptive modeling techniques to model, process, analyze, and represent data, whether based on measurements or some representation of the data.
- Creating algorithms for decision making with uncertainty, sequential decision making systems and understanding their limits of performance.
- And much more.

One of the big questions in machine learning right now is understanding, fundamentally, what is learnable from large, unstructured data, collected automatically through massive user bases, said Singer, the Fox Family Professor in Electrical and Computer Engineering.

“We’re analyzing the convergence properties and philosophically looking at limits of machine learning,” Singer said. “If God and a supercomputer had access to this data, what could they learn from it?”





If you encode the information with redundancy—which helps in preventing and correcting errors—you can read it back without errors.”

**OLGICA MILENKOVIC**  
PROFESSOR, ELECTRICAL AND  
COMPUTER ENGINEERING

## COMPUTATIONAL GENOMICS

With our society’s ever-growing volume of data, DNA is emerging as a potential storage media of unprecedented density, durability, and efficiency.

Developing DNA as a viable data storage system requires a combination of coding and information theory, mathematics, and theoretical computer science to convert data. CSL’s Olgica Milenkovic’s research, which has been featured in *The New York Times*, *Nature*, and other media, employs this discipline to encode data in a manner suitable for portable and robust DNA-based data storage systems.

When data is put on any storage device, from a floppy disk to a strip of DNA, a “coding language” needs to be created so that the system can write, read and store, and then translate information back without detrimental errors. To make DNA into a viable medium, researchers must create a unique data coding system suitable for writing via DNA synthesis and reading via high-throughput sequencing.

DNA molecules are built using 4 nucleotides: cytosine, guanine, adenine, and thymine [C, G, A, and T]. These letters, along with specific association and context-based grammatical rules, become the language that Milenkovic uses to store data.

“One can make DNA strings that contain any desired information by arranging the C, G, A, T letters in a certain manner,” said Milenkovic, a professor of electrical and computer engineering. “If you encode the information with redundancy—which helps in preventing and correcting errors—you can read it back without errors.”

To test the method, Milenkovic and her team recently stitched the data of a *Citizen Kane* poster and other images into the DNA. When they retrieved it without coding redundancy, the images were unrecognizable. When only 15% of redundancy was added, they came back perfectly intact—with no errors.

## SONIC

Thanks to advances in computing, today’s smart phones are as powerful as yesterday’s supercomputers. But to continue advancing Moore’s law in an era of nanoscale computing, researchers will have to develop new ways to maintain reliability on ever-shrinking devices.

The \$30 million Systems On Nanoscale Information fabriCs (SONIC) Center, a multi-university initiative led by Illinois, is addressing the problem by changing the computing paradigm—using information processing instead of data-processing—to extend scaling of nanoscale devices beyond what is possible today. An important part of this work? You guessed it—machine learning.



“One of the things we do in SONIC is build systems with low energy constraints,” said SONIC Director Naresh Shanbhag, the Jack S. Kilby Professor of Electrical and Computer Engineering. “The systems of the future will have a very small processor, with a small amount of storage. We’re building systems that pack a lot of information extraction capability with a very small amount of battery power but still provide actionable intelligence.”

In many current systems, a device would send data to the cloud, which would process it and send information back to the device—costing time and energy. SONIC researchers are using machine learning to develop *in situ* analytic capabilities, enabling chip designers to embed a processor right in the heart of a memory array. This is revolutionary, as the circuits used to develop processors [high voltage] are largely incompatible with the circuits used to design memory [low voltage]. Machine learning powers the deep in-memory computing necessary to eliminate the gap between the two.

SONIC researchers have already built prototypes using this model, says Shanbhag. The work has been funded through the Semiconductor Technology Advanced Research network [STARnet].

“We’ve taken a very foundational view of this problem, achieving intelligence with minimum energy consumption, and shown that it can actually be done,” he said.

## VIRTUAL TEACHER

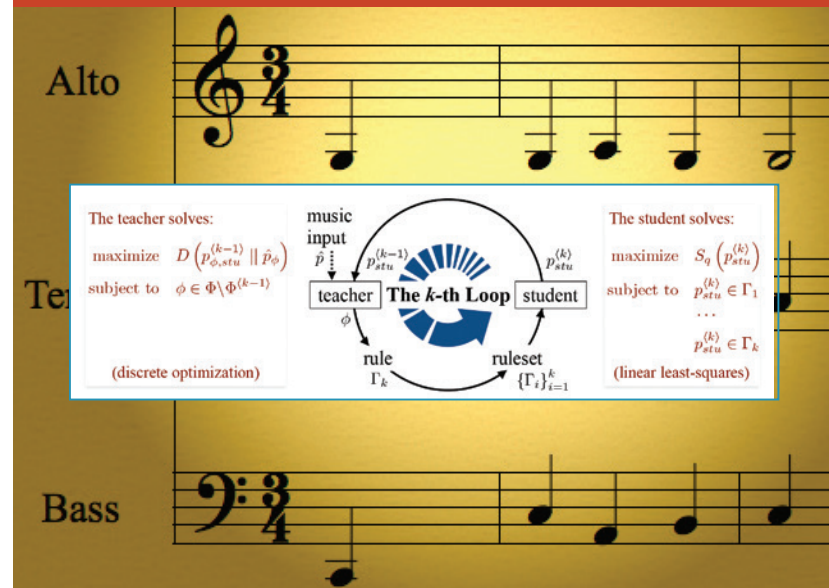
Much of machine learning research is focused on teaching machines how to learn. But CSL Assistant Professor Lav Varshney, ECE, and graduate student Haizi Yu want to go a step farther: they want to teach machines how to teach you.

Using a Bach corpus as the input, Yu has developed technology called MUS-ROVER, which facilitates experiential learning—in this case, of music. Not only can MUS-ROVER put together unique chord sequences, but it is also able to deconstruct the musical concepts and, in turn, tutor humans in how to compose music based on the results.

“We wanted to create technology that not only adapts to new tasks, but is also able to explicitly tell users what has been learned, not only in terms of results, but also in knowledge,” said Yu, who is pursuing a PhD in computer science at Illinois. “We’re asking the machine to go beyond classic prediction and performer tasks and teach us what it has learned.”

Yu says the technology works well, though not perfectly. In some areas, the machine picked up on elements that humans have missed—for example, showing patterns in repeating intervals. In other

Not only can MUS-ROVER put together unique chord sequences, but it is also able to deconstruct the musical concepts and, in turn, tutor humans in how to compose music based on the results.



areas, MUS-ROVER missed some elements that are easy for humans to understand, such as hierarchical representation and emotive qualities.

Further research will focus on refining the model so that it is more powerful and more precise. Yu also plans to apply it to different domains, such as genomics, in the future.

“We chose music as a first application area because it’s relatively simple in terms of domain knowledge—there are only so many options for chords—and also because we have a robust understanding of music theory,” he said. “It makes it easy to evaluate how successful our model is.”



## :AERIAL IMAGING TECHNOLOGY PROVIDES DIAGNOSTIC TOOL FOR AGRICULTURE

Naira Hovakimyan helped launch a start-up, which provides diagnostics for the agriculture industry using advanced aerial imagery.

Disease. Weeds. Nutrient deficiency. Weather damage. These are just a few issues that can arise in agricultural fields, but thanks to IntelinAir, a start-up co-founded by CSL Professor Naira Hovakimyan, these problems are becoming easier to detect for farmers.

IntelinAir, Inc. utilizes drones and airplanes with advanced imaging to conduct what the company calls an Ag-MRI™. With imaging analytics, the technology can conduct a health analysis of a field and provide insights to farmers.

“Just as an MRI uses imagery to detect problem areas in your body, IntelinAir’s proprietary analytics pinpoint trouble spots and give farmers guidance on what to prioritize in their field,” said Hovakimyan, the company’s co-founder and chief scientist.

With computer vision and deep learning methodologies, the company’s technology can learn to spot abnormal crop conditions and adapt over time to changing field conditions.

The technology can prompt tissue samples of leaves that look damaged, for example, so farmers can understand whether the problem is from disease or insects. The imaging can also analyze how many seeds emerged after planting or were lost, prompting the farmer to consider different planting strategies or nitrogen treatments, or alerting them to look for early warning signs of spreading disease.

For beta testing this growing season, IntelinAir had teams of flight specialists capture hundreds of thousands of high resolution images over thousands of acres of fields, including Illinois corn and soybeans, vineyards in California, and research plots in the northern Great Plains.

“The proprietary software developed by IntelinAir engineers is a powerful and unique solution that can take the thousands of images of each field, compile them into one field image, and then identify the anomalies in that field in a clear and concise manner,” said Bob Coverdill, director of flight operations.

The company brings data analytics, aerial imagery, and deep learning from the tech world to agriculture. They have long been used in robotics and computing, but now bring new opportunities to the next generation of agriculture, as we face a future in which population growth requires increased production.



"I've had the opportunity to spend the last 25+ years working with many industries, including aerospace, healthcare, oil production, first response and elderly care, to find ways that mathematics, physics, and computer science can offer solutions to various robotics and engineering problems," said Hovakimyan, a professor of mechanical science and engineering. "I couldn't be more excited about what the future holds for agriculture and how I can play a role in it."

IntelinAir incorporated in September 2014 and has now grown to nearly 20 employees with offices in San Jose, California and Champaign and several corporate connections, including the John Deere Operations Center.

The team, which has been developing the technology through in-field trials, is currently creating an app, which is set to launch in April 2017, in time for the next growing season.

“

Just as an MRI uses imagery to detect problem areas in your body, IntelinAir's proprietary analytics pinpoint trouble spots and give farmers guidance on what to prioritize in their field.”

NAIRA HOVAKIMYAN



## :QUICK LOOK

Congratulations to the following CSL researchers:



### BILL GROPP

CSL and CS Professor Bill Gropp received the 2016 ACM/IEEE Computer Society Ken Kennedy Award for “highly influential contributions to the programmability of high performance parallel and distributed computers, and extraordinary service to the profession.”



### NAM SUNG KIM

Nam Sung Kim, CSL associate professor of electrical and computer engineering, has been inducted into the IEEE/ACM International Symposium on Microarchitecture [MICRO] Hall of Fame, an honor given to outstanding researchers who have consistently contributed to MICRO with high-impact research.



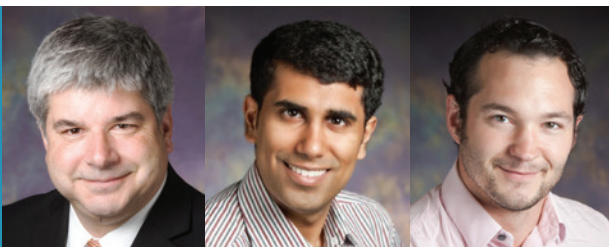
### ZICHAO YE

Zichao Ye, a PhD student in materials science and engineering and advised by CSL and MatSE professor Les Allen, won a Best Paper Award at the National Thermal Analysis meeting [ICTAC/NATAS].



### LIN-YU LU, HAO JAN LIU, & HAO ZHU

ITI researchers Lin-Yu Lu [Steven], Hao Jan Liu [Max] and ITI and ECE Assistant Professor Hao Zhu [pictured left to right] were awarded 2nd Best Paper at the 2016 North American Power Symposium [NAPS].



### WILLIAM SANDERS, UTTAM THAKORE & GABE WEAVER

ECE department head William Sanders received the 2016 IEEE Innovation in Societal Infrastructure Award and Best Paper Award with CS PhD student Uttam Thakore and ITI researcher Gabe Weaver [pictured left to right] at the 2016 International Conference on Dependable Systems and Networks.



## :ARJUN ATHREYA INVESTIGATES BIOLOGICAL MARKERS OF DISEASE

Arjun Athreya spent his summer interning at Mayo Clinic, where he helped researchers identify how individual patients respond to certain drug treatments.

Big data analytics has endless possibilities in health care. Through data analysis, scientists can determine subtypes of diseases, as well as how drug treatments will influence individual patient prognoses. Arjun Athreya, a CSL PhD student in electrical and computer engineering advised by CSL's Ravi Iyer, spent the summer at the forefront of this work in precision medicine at Mayo Clinic.

His research is part of the Mayo-Illinois Alliance, which combines researchers from the University of Illinois and Mayo Clinic to promote a broad spectrum of collaborative research for the development of new technologies and clinical tools for individualized medicine.

### METFORMIN AS A CANCER DRUG

Metformin, an anti-diabetic drug, has shown promise in treating triple negative breast cancer, a molecular subtype of cancer for which there are no targeted treatments yet. Triple negative breast cancer (TNBC) is not driven by the three receptors known to fuel most breast cancers, so it doesn't respond to current targeted receptor treatments.

Athreya's data-driven analytics and machine learning research allowed Mayo Clinic scientists to more closely examine the molecular mechanisms of TNBC. Using single cell techniques, they found that metformin shows preliminary effectiveness in reducing or preventing further tumor growth in this type of cancer.

"Precision medicine is about identifying disease subtypes of a particular disease, and deciding which treatment is best for each subtype," said Athreya. "We found that metformin, which normally treats diabetes, also had therapeutic effects on this certain type of breast cancer."

Athreya worked with Dr. Liewei Wang and Dr. Richard Weinshiboum from Mayo Clinic to investigate the particular genes in TNBC that were affected by metformin. Athreya determined that a small cluster of cells showed a different distribution in gene expression after metformin treatment. With further help from bioinformatics expert Dr. Rani Kalari and her team, they identified one gene for laboratory experiments, which established that it inhibits cancer cell proliferation and migration.

"I took data that was more complex than what biologists could see under a microscope. You can't functionally study 20,000 genes—that's very expensive," said Athreya. "So we used algorithms and data analytics to narrow down the hypothesis to test just a few genes, and we were able to find key genes."

The Mayo team has conducted a clinical trial that included many TNBC patients to begin the process of developing a therapeutic pipeline. Because of the unique characteristics of TNBC, it does not always respond to treatment.

"Because we know triple negative is a whole other beast, success of any drug treatment is going to be very variable. We're trying to understand: what is the baseline biological difference between women who have shown therapeutic effects and the ones who haven't?" said Athreya.

The team is building a model using a game theory approach that may be able to predict—given genes as biomarkers—whether a patient will respond to drug treatment. They can determine with about 95% accuracy in predicting the women who will and will not respond, but it is still being explored. Such a model is now helping further probe the reasons why some patients may be predisposed to respond better to the drug.

## :EVENTS



### FOOD AND DATA WORKSHOP

The Food and Data Workshop on September 12-13, organized by CSL and ECE assistant professor **Lav Varshney**, gathered academic and industry representatives together to share work on the relationship between data and food. The food pipeline is packed with data and has the potential for individualized, analytics-based optimization, but data is often siloed within different parts of the system. Pressing global food challenges due to climate change, obesity, malnutrition, and other factors requires interoperability to understand the end-to-end relationship between food and data.



### ALLERTON CONFERENCE ON COMMUNICATION, CONTROL, AND COMPUTING

On September 27-30, the 54th Allerton Conference on Communication, Control, and Computing attracted 426 attendees from industry, academia, and government to discuss research and innovation. Co-chaired by CSL's **Minh Do** and **Naira Hovakimyan**, the four-day conference featured two opening tutorial sessions from **Panagiotis Tsiotras**, of Georgia Institute of Technology, and **Emmanuel Abbe**, of Princeton University, as well as a plenary lecture by **Naomi Ehrlich Leonard**, Princeton University.



### SONIC ANNUAL MEETING

SONIC hosted its Year 4 annual review meeting on October 5-6, drawing together more than 130 faculty, staff, and sponsors. The meeting showcased research focused on the design of robust, energy efficient, and intelligent computing platforms using emerging nanoscale devices, which

are inspired by the information processing principles found in communication and biological systems. The conference included a student poster and project demo session, overviews of ongoing SONIC research, and more.



### SYMPOSIUM ON FRONTIERS IN BIG DATA

The Symposium on Frontiers in Big Data, hosted by CSL on September 23-24, brought together more than 400 in-person attendees and 27 speakers to discuss a wide range of big data-related topics. The conference, supported by the Grainger Engineering Breakthroughs Initiative at Illinois, examined big data's role in solving real-world problems and is coming at a critical time when the amount of data generated exceeds our ability to store, analyze, and curate it. Expanding and developing more advanced analysis and optimization techniques could lead to breakthroughs.

# GET TO KNOW NORMAND PAQUIN

## ASSOCIATE DIRECTOR OF RESEARCH

On a day-to-day basis, you may find Normand Paquin organizing a kickoff meeting for a new research program, pitching a proposal for a new \$20 million center to government officials, or working out intellectual property details with industry partners. And these are just a few of the many activities he's responsible for as CSL's Associate Director of Research.

CONNECT talked to Paquin, a Montreal native who holds a B.Sc. in engineering from Queen's University [Canada] a PhD in physics from the University of Cambridge [UK], and an MBA from the University of Illinois at Urbana-Champaign, about how he's helping to support and shape research activities in CSL.



**Q: Before you joined CSL, you held various positions in research and development spanning both academia and business. Can you tell us about your background?**

**A:** My father was a civil engineer and I enjoyed understanding how things worked. I studied engineering physics, which is a really useful degree in that it gives you fundamentals that allow you to reach across a large number of fields in engineering and science. After graduating, I spent six years working for an R&D firm, often negotiating university sub-contracts. I also worked for an IT consulting firm, where I learned to be very customer-focused and handle complex projects. All these experiences helped pave the way for my current role as a bridge between researchers and the people who fund and support research.

**Q: Why did you make the leap from hands-on research to business?**

**A:** Much of my Ph.D. work involved doing experiments late at night and alone, and it wasn't for me. I got a distorted sense of what research can be; I look at faculty here and they are intensely collaborative and mentor students into becoming adept researchers. I made the leap to industry, and it was a good fit. When I joined a private firm as a research scientist, they were struggling with a sub-component of a \$65 million project. Although it dealt with DC-DC power converters—nowhere near my area of expertise—it turned out that I was good at sorting out the issues. I learned I had a knack for bringing ideas and people together and enabling teams to make things happen and that I really enjoyed it.

**Q: What is the underlying philosophy behind how you approach your CSL role?**

**A:** My approach is to enable faculty to have a major impact, and do everything I can to help them succeed—whether it's developing research themes, putting together proposals, or launching newly funded projects. I want faculty to have impact, excel in their scholarship, and see the latter recognized at a national level. That's what drives me.

**Q: You've been at the University since 2003. How has the research climate changed during that time?**

**A:** There's been increasing pressure to do more with less. Industry and even federal funding agencies are looking to leverage their investments and see at least the potential for societal and/or economic returns. Funding is increasingly directed towards interdisciplinary research to address problems for which only teams of experts working together can develop transformative, innovative, but also practical solutions.

**Q: What are the challenges and opportunities in the current research landscape?**

**A:** We face the challenge [and opportunity] of an innovation cycle that is continually accelerating. Fortunately for CSL, much of that is driven by IT innovation, which is at CSL's very core.

**Q: What does the CSL of the future look like? Where do you want to see this lab in 20 years?**

**A:** Our future is very bright. There's incredible excellence in our faculty, students, and leadership. There are not many units on campus that know how to do what CSL does. CSL is well poised to pursue new interdisciplinary efforts; we are reaching out across campus and being well received. I expect growth of CSL-driven research through new partnerships. Much of that will be virtual—unless we get a major gift, our ability to expand our physical space will likely be constrained.

**Q: How do we need to grow to make that happen?**

**A:** We will have to diversify our sources of funding. New partnerships with industry, funding agencies, and foundations will be important, as will finding new ways to leverage resources.

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