The TREND *in Engineering*

THE UNIVERSITY OF WASHINGTON COLLEGE OF ENGINEERING NEWSLETTER AUTUMN 2014

The Wide Reaching Impact of Big Data Mining

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Dean's Message

As we embark on a new academic year, I look forward to the campus coming alive again and to what our entrepreneurial students and faculty will achieve. If we continue to build upon the achievements of this last year, the future is bright indeed. This past year brought unprecedented funding to UW Engineering from national foundations, once again demonstrating the quality and productivity of our faculty. In this issue of *The Trend* you'll learn more about one of those initiatives in big data, an area where we are a national leader. Last November, the UW, UC Berkeley, and New York University received a five-year, $37.8 million grant from the Gordon and Betty Moore Foundation and the Alfred P. Sloan Foundation. Our feature story (see pages 4-5) delves into the many aspects of this interdisciplinary work and how UW expertise in this area benefits a host of other fields and our students' educational experience.

Excellent faculty and robust research programs provide a world of opportunity to our students. As part of our commitment to provide our students with the best educational experience possible, we formed a student advisory group and asked them to conduct a study on the student experience. This group is comprised of bright and engaged students and will be a sounding board for me on a variety of topics. Recently, they met with our leadership team to review the results of their study. One conclusion is that we need to further streamline and improve the admissions process to the college. The student feedback has been invaluable as we actively identify and develop ways to make their world-class education even better.

Collaborating with our students and faculty is invigorating and inspiring. As we welcome the class of 2018 this fall, I look forward to the new and continuing ways that UW Engineering develops the next generation of innovators and leaders. Fall quarter is filled with many events including the annual lecture series and Homecoming. I hope to see you on campus soon.

Mike Bragg
Frank & Julie Jungers Dean of Engineering

Welcoming a new class of innovators

Exceptional new faculty members will join the college this year. We highlight two below. Meet them all at www.engr.uw.edu/newfac2014

Franzi Roesner
Computer Science & Engineering

A recent UW Ph.D. graduate, Franzi Roesner will return to the CSE classroom this fall as an assistant professor. Her research focuses on security, privacy, and human computer interaction in system design. She examines security and privacy challenges posed by existing and emerging technologies such as third-party tracking on the Internet and vulnerabilities in smartphones and augmented-reality platforms like Google Glass and Xbox Kinect.

Jonathan Liu
Mechanical Engineering

Jonathan Liu joins us from the State University of New York at Stony Brook where he was an assistant professor of biomedical engineering. He directs the Molecular Biophotonics Laboratory where his research focuses on developing biomedical optical devices and molecular contrast agents for cancer diagnostics and therapy. Examples include miniature handheld microscopes for real-time optical biopsy of living tissues, as well as spectral-imaging endoscopes for in vivo molecular screening of disease biomarkers.

Engineering leaders on the move

Human Centered Design & Engineering welcomes David McDonald as chair

David comes to HCDE from the UW's Information School and brings a breadth of experience as a leader, educator, and researcher. David's research interests span computer supported cooperative work, human-computer interaction, and social computing. Currently, David has ongoing projects studying mass interaction in Wikipedia and other online communities. While at the iSchool, David spent two years as a program officer at NSF in the Computer & Information Science & Engineering Directorate, Information & Intelligent Systems Division, and Computing and Network Systems.

Linda Ng Boyle to lead Industrial & Systems Engineering

A respected national leader in the field of transportation safety, Linda directs the Human Factors and Statistical Modeling Lab and serves as the associate director of research and on the board of directors of the Pacific Northwest Transportation Consortium. Linda's research centers on driving behavior, crash countermeasures, crash and safety analysis, and statistical modeling. Prior to joining the UW in 2009, Linda was an associate professor at the University of Iowa and a senior researcher at the U.S. Department of Transportation. She chairs the Transportation Research Board (TRB) Committee on Statistical Methods and also serves on the TRB Committee on Simulation and Measurement of Vehicle and Operator Performance.

Vikram Jandhyala named vice provost for innovation of UW's Center for Commercialization

Vikram Jandhyala, an electrical engineering professor and an inaugural Center for Commercialization entrepreneurial faculty fellow, was appointed to the new position of Vice Provost for Innovation. Prior to joining the UW, he worked in the electronic design software industry. Vikram chaired Electrical Engineering from 2011 until earlier this year. Working with his students, he founded Physware (now Nimbic Inc.) in 2006, a venture-backed cloud-based simulation software company that was acquired by Mentor Graphics this year. His current research interests are social and organizational networks, computational science and big data, electronic design automation, technology entrepreneurship and educational innovation.

John Sahr named interim chair of Electrical Engineering

As the college begins a chair search for Electrical Engineering, John Sahr has stepped in to lead the department during this interim period. John brings a depth of leadership experience to this role. He is currently the UW's associate dean of undergraduate academic affairs overseeing the Office of Educational Assessment, Classroom Support Services, the Teaching Academy and the Robinson Center for Young Scholars. In the EE department, John has been graduate program coordinator and most recently the associate department chair managing infrastructure and advancement.

Nominate an Exceptional Engineer for a Diamond Award

The Diamond Awards honor outstanding alumni and friends who have made significant contributions to the field of engineering. If you know an engineer who deserves recognition, we want to hear from you! Take time to nominate an engineer to join the distinguished ranks of Diamond Award honorees. Deadline for nominations is Friday, October 10. www.engr.uw.edu/da

Democratizing BIG DATA

By Sarah DeWeerdt

SeaFlow, a research instrument developed in the lab of UW School of Oceanography director Ginger Armbrust, analyzes 15,000 marine microorganisms per second, generating up to 15 gigabytes of data every single day of a typical multi-week-long oceanographic research cruise.

UW professor of astronomy Andy Connolly is preparing for the unveiling of the Large Synoptic Survey Telescope (LSST), which will map the entire night sky every three days and produce about 100 petabytes of raw data about our universe over the course of 10 years. (One petabyte of music in MP3 format would take 2,000 years to play.)

What scientists like Armbrust and Connolly have is popularly known as "big data," and as rich and exciting as it can be, big data can also be a big problem.

"Every field of discovery is transitioning from data-poor to data-rich, and the people doing the research don't have the wherewithal to cope with this data deluge," says Ed Lazowska, director of the UW's eScience Institute. "And it's not just the volume of data that's increasing relentlessly, it's the velocity and the variety too - the 3 V's." The result is that many scientists spend more time wrangling data than actually doing science.

The eScience Institute aims to change that by connecting researchers with experts in large-scale data management, data analysis, data visualization, machine learning and related fields. Researchers from across the campus gain the skills and tools they need to work with increasingly enormous data sets, while data scientists advance their own research by grappling with real-world problems.

And now, the eScience team — the core team includes faculty from 12 departments representing five schools and colleges — is poised to scale way up. Last year, the UW won a five-year, $37.8 million grant from the Gordon and Betty Moore Foundation and the Alfred P. Sloan Foundation that will be shared with New York University and the University of California, Berkeley, to foster a data science culture at the three universities.

At the UW, that shift is already underway. The eScience Institute was founded in 2008, modeled in part on the university's Center for Statistics in the Social Sciences, which has been in existence for nearly 15 years.

"Having the history of CSSS, and having the eScience Institute in operation at a modest scale, provided a lot of experience that helped us convince the sponsors to give us this grant," says Bill Howe, associate director of the eScience Institute. "Institutionally and culturally I think we are a bit ahead of the curve."

In addition to the Moore/Sloan Foundation grant, the eScience Institute also received $9.3 million from Washington Research Foundation to aid in hiring faculty and postdoctoral fellows, and $2.8 million from the National Science Foundation to support creation of an interdisciplinary graduate program in data science. "You need to have career paths for people who simultaneously do science and build tools," says Lazowska. "We want to create them, hire them, and reward them."

Real-time Analysis of a Sea of Data

Researchers who have worked with the eScience Institute call the experience transformational.

"Out of these collaborations come not just faster but new ways of thinking about our studies and the kinds of questions we can ask," says Armbrust. "The faster part is great. But that's not as important as the new ways of doing things."

Armbrust sought help from the eScience Institute for dealing with the massive streams of data generated by her lab's SeaFlow instrument. Out of that collaboration came SQLShare, a web-based tool that makes database technology accessible to non-specialists.

A plot of multicolored dots dances on Armbrust's computer screen: data from an ongoing research cruise. The colors represent different types of phytoplankton — the base of the marine food web — shifting in abundance as the ship moves through the water. The research vessel is far out in the Pacific Ocean, but Armbrust sees the data in her Seattle office with just an eight-minute delay.

"Most of the time when you're at sea you're sort of driving blind," Armbrust says. In the past, oceanographers often couldn't analyze their data and identify interesting phenomena in the ocean until days after passing it by — too late to follow up. "Now we're watching things in real time and we can make choices in real time.

Real-time analysis in SQLShare also bolsters collaborations across disciplines. Armbrust recently organized a workshop that brought together 40 oceanographers from different disciplines. They loaded dozens of individual data sets — all collected on the same research cruise — into SQLShare, and during the meeting two data scientists from the eScience Institute typed in queries as ideas for scientific analyses came up in the conversation.

The oceanographers were able to investigate the relationship between zinc and cobalt, for example, or how salinity affects the levels of a certain virus, almost as easily as people look up an actor's filmography or consult Wikipedia on their smartphones during cocktail party conversation. "It was a blast," Armbrust says.

Scaling Up to Astronomical Data Sets

In the Department of Astronomy, Connolly has worked with the eScience Institute to develop algorithms to sort through the massive amounts of data that will come from the LSST project. For example, researchers hope the telescope's 3.2-billion-pixel camera will help detect asteroids; orbiting chunks of rock that can help reconstruct the evolution of the solar system — not to mention identify which ones have the potential to slam into the Earth.

LSST data may enable astronomers to detect up to 10 million asteroids within our solar system. But they won't be able to do it the old-fashioned way. Traditionally, astronomers detect asteroids by rapidly toggling back and forth two pictures of the night sky taken a few hours apart.

"It's really effective — your eye is really good at this," Connolly says. "But it doesn't scale."

Connolly worked with eScience experts to develop algorithms that can detect objects that move like asteroids on LSST images, returning to the same region of the sky every few nights to see what has moved.

"It's like playing the world's largest game of connect-the-dots," Connolly says. "You can answer all of those questions with the same data set, you're just looking at it in different ways. That's where the computer science comes in."

Sharing Data Science Know-How

These questions also reflect widespread issues in computer science — problems like tracking and detection of anomalies. As such, algorithms that are developed to help astronomers do their work can have much wider application. "We've had a number of examples where people in different fields really do have problems that are similar enough that they can utilize the same solutions," Lazowska says.

The institute's algorithm for bringing people together will get a big boost in October, when the former library on the sixth floor of the Physics/Astronomy building is slated to reopen as a campus-wide Data Science Studio: a collaboration space, providing a central spot for like-minded researchers to gather.

As demand increases at the UW for their expertise, eScience Institute data scientists are expanding their reach despite their limited numbers. One strategy is the Data Science Incubation Program, in which researchers across campus pitch their data analysis projects, then send a lab member to collaborate with eScience experts for one or two quarters to build a solution.

"We don't want this to be a magic trick that only computer scientists know how to do," Howe says. "It should be something that everybody can do."

UW students' electric-hybrid car takes 2nd in international competition

By Doree Armstrong

The UW's Advanced Vehicle Works team took on more experienced competitors and won second place in the international EcoCAR 2 competition this summer. The team was recognized for turning a Chevrolet Malibu into a highly efficient hybrid vehicle running on electric grid energy and biodiesel.

The UW competed against 14 other teams from the U.S. and two from Canada in the three-year competition, sponsored by the U.S. Department of Energy and General Motors Co. Teams spent the first year designing their car, the second year implementing the designs, and the third year refining those designs and testing the car against a variety of benchmarks.

"This was a big surprise because this was our first time doing an advanced vehicle competition," said Kate Kitto, the team's communications manager, a sophomore in communications. "Ohio State, this year's winner, has been doing this kind of thing for 30 years and we've been doing it for only three years so we were really happy to get second place. We're just building the foundation for the program."

The UW team's Malibu has a biodiesel engine that powers the front wheels, while the back end's 250-horsepower electric motor uses a 400-pound battery pack. The car can travel 48 miles on one electric charge before switching to the biodiesel engine.

The vehicle design is called Parallel-Through-the-Road Plug-in Hybrid, which means the front and back wheels are not connected through a drive train. "Hypothetically, if you cut the car in half the front could operate itself and the back could operate itself," Kitto said.

Team members spent a week in Detroit testing out their car at GM's Milford Proving Ground, and then traveled to Washington, D.C., to give technical presentations to panels of judges.

In addition to second place overall, the team won another nine awards, including best 0-60 mph time (6.95 seconds), lowest greenhouse gas emissions and lowest energy consumption.

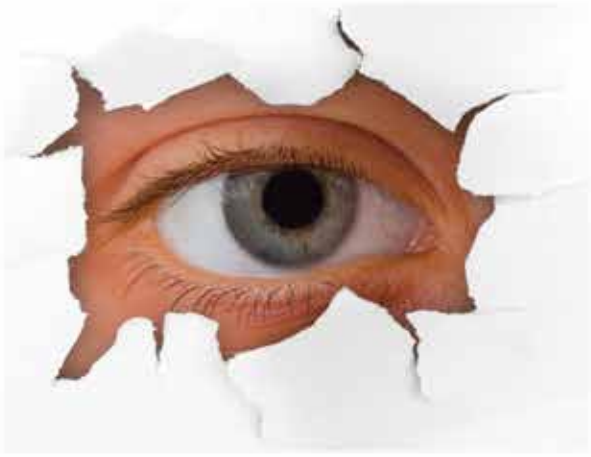
The UW team has about 45 team members, majoring in engineering, business, communications and graphic design.

The team received $25,000 in seed money from the competition organizers, which the UW's Department of Mechanical Engineering matched. With additional money from donors and thousands of hours of labor, Kitto said, the team estimates the Chevy Malibu has cost about $800,000 to develop.

"They give you three years to build a hybrid car while we're all going to school, working, and doing other things," Kitto said. "A lot of the engineers this spring were working 70 to 80 hours a week on the car in addition to going to school. We're really proud of the car we built."

The team has been selected to participate in EcoCAR 3, which begins this fall and requires reworking a Chevrolet Camaro. That competition will last four years to give teams more time to work on implementation and testing.

Sensor in eye could track pressure changes, monitor for glaucoma



Your eye could someday house its own high-tech information center, tracking important changes and letting you know when it's time to see an eye doctor.

UW engineers led by Karl Böhringer, a professor of electrical engineering and bioengineering, have designed a low-power sensor that could be placed permanently in a person's eye to track hard-to-measure changes in eye pressure. The sensor would be embedded with an artificial lens during cataract surgery and would detect pressure changes instantaneously, then transmit the data wirelessly using radio frequency waves.

The research team wanted to find an easy way to measure eye pressure for management of glaucoma, a group of diseases that damage the eye's optic nerve and can cause blindness. Right now there are two ways to check eye pressure, but both require a visit to the ophthalmologist.

If ophthalmologists could insert a pressure monitoring system in the eye with an artificial lens during cataract surgery, it could save patients from a second surgery and essentially make their replacement lens "smarter" and more functional.

The team is working on downscaling the prototype to be tested in an actual artificial lens. Designing a final product that's affordable for patients is the ultimate goal, researchers said.

Automated age-progression software lets you see how a child will age

It's a guessing game parents like to ponder: What will my child look like when she grows up? A computer could now answer the question in less than a minute.

UW computer scientists have developed software that automatically generates images of a person's face as it ages through a lifetime. The technique is the first fully automated approach to show age progression from babies to adults that works with variable lighting, expressions and poses.

"Our extensive user studies demonstrated age progression results that are so convincing that people can't distinguish them from reality," said co-author Steven Seitz, a UW professor of computer science and engineering.

The most promising potential use of the software is to help find missing kids. Lead researcher Ira Kemelmacher-Shlizerman contacted the Center for Missing and Exploited Children and was told her software's ability to utilize even a single toddler photo can be valuable because "photos of kids from zero to five years old are the most difficult ones to produce. And they are actually the most important ones," she said.

Campus News »

New engineering building to house nanoengineering research

In 2016, the new Nanoengineering & Sciences Building will be completed on campus. The 78,000-square-foot building will be adjacent to the Molecular Engineering & Sciences building and is the result of an agreement with Sound Transit to mitigate the impact of the new rail line running under campus.

The majority of College of Engineering buildings are located adjacent to the new Sound Transit rail line and the UW station at Husky Stadium. The construction and operation of this light rail extension creates electromagnetic interference that will impact important engineering research. Many labs employ delicate and highly sensitive research instruments, like electron microscopes, and as a result need a stable and controlled environment.

The agreement between the UW and Sound Transit provides a long-term solution that will support the maintenance and growth of significant engineering research in the new building designed for collaborative exploration.

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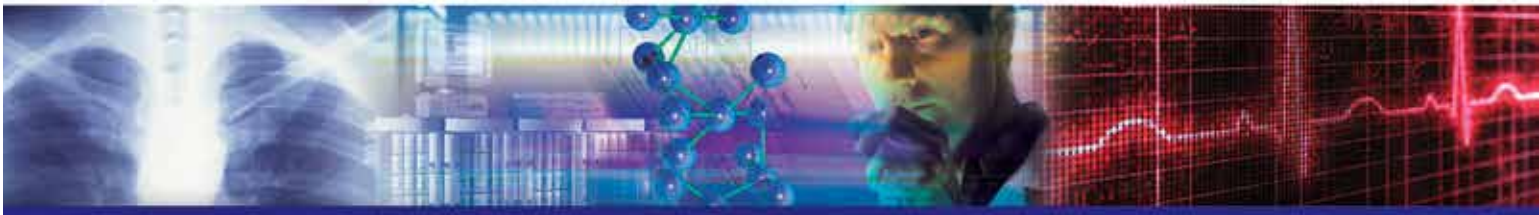

2014 Engineering Lecture Series Engineering the Heart: From Cell Therapy to Computer Technology

Engineering a Broken Heart

Wednesday, October 15

Charles Murry, Professor of Pathology, Cardiology, and Bioengineering

The heart is a miraculous muscle. Yet every year for over one million people this vital organ quits. Heart muscle damage, most commonly caused by a heart attack, can lead to heart failure when the organ forms scar tissue rather than growing new muscle tissue. UW researchers are merging engineering technology, stem cells and medicine to regenerate heart muscle. The team recently published a significant breakthrough that brings us closer to addressing our nation and world's top public health concern within the decade.

Get a Grip: Cell Biomechanics in Cardiovascular Health

Tuesday, November 4

Nate Sniadecki, Associate Professor, Mechanical Engineering
Nathan White, Adjunct Assistant Professor, Bioengineering

Our cardiovascular system depends on active cells that stretch, contract and twitch to keep our bodies healthy. These cells create blood clots when we have an injury to prevent blood loss and help pump blood through our bodies during exercise. By studying the biomechanics of these cells, mechanical engineers and physicians at the UW are finding lifesaving solutions that improve blood clotting to help us heal from traumatic injuries. Come hear how their work is changing medicine at a cellular level.

Cutting the Cord: Wireless Power for Implanted Devices

Tuesday, November 18

Joshua Smith, Associate Professor, Computer Science & Engineering and Electrical Engineering

You or someone you know may rely on a cardiac pacemaker, heart pump or other implantable device. Powering these common medical devices is challenging. Existing approaches include batteries that must be surgically replaced every few years and cables extending out of the body, which can attract infection. It is becoming increasingly feasible to use wireless signals from a source placed in clothing or furniture—and perhaps even from cellular and television signal towers—to power implanted devices. Learn about emerging wireless technologies that may impact the quality of life for many individuals.

All lectures are at 7pm, Kane Hall, UW Campus – FREE!
Registration required, online at UWalum.com/engineering or call (206) 543-0540.

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