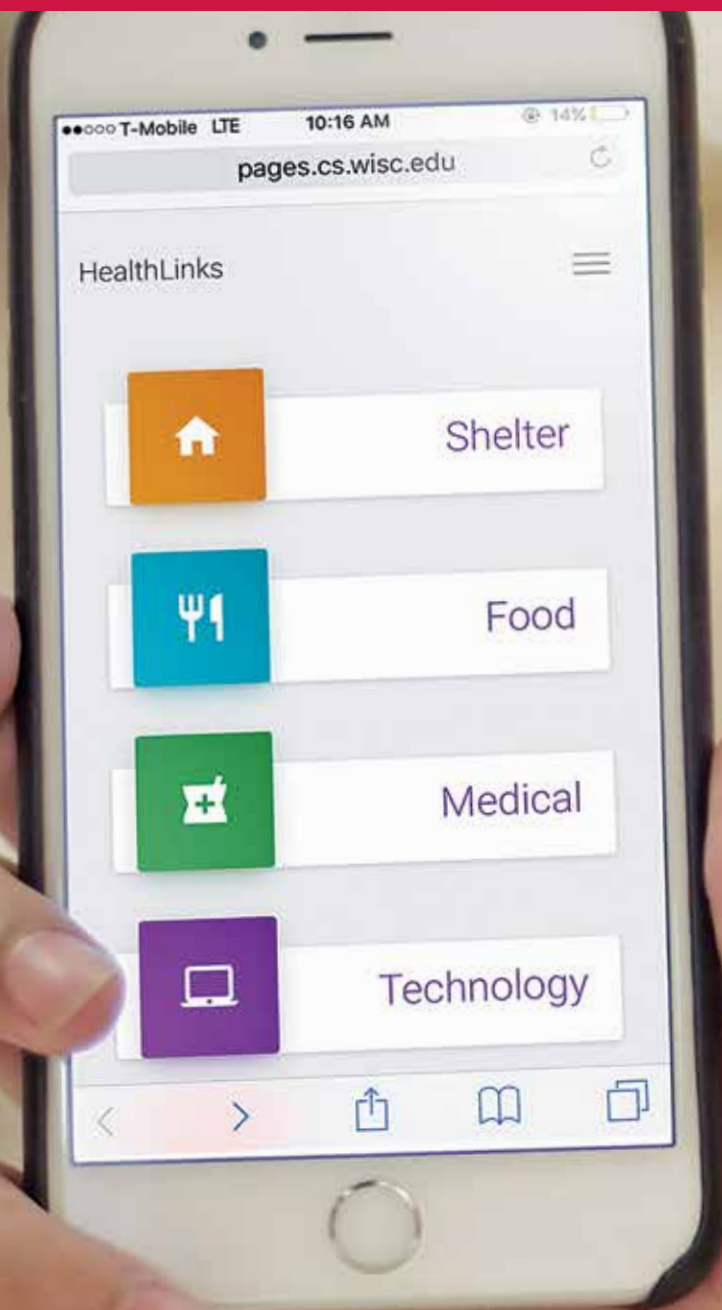


INDUSTRIAL AND SYSTEMS ENGINEERING



UNIVERSITY OF WISCONSIN-MADISON



SMARTPHONE APP

LINKS LOW-INCOME RESIDENTS WITH CRITICAL SERVICES



Jeffrey Linderoth

GREETINGS!

My first year as department chair is in the books, and it was a great year for our department!

Our students are continuing to impress and find

success. For example, students from Nicole Werner's lab earned numerous accolades, including a Baldwin Wisconsin Idea Endowment grant for their app "Health Links." The smartphone app seeks to connect low-income Madisonians with community resources such as food pantries, shelters and health centers. You can read more about the app later on in the newsletter.

Speaking of healthcare, not only do our students excel, but our faculty members do as well. A case in point: Pascale Carayon has been selected to lead the Grainger Institute for Engineering's new research thrust in smart and connected healthcare. This transdisciplinary effort will enable innovative collaborations across the engineering campus in coordination with the School of Medicine and Public Health aimed at transforming the healthcare experience.

This year, the ISyE department has also created a new research institute focused on healthcare, the Wisconsin Institute for Healthcare Systems Engineering (WIHSE). WIHSE held its inaugural conference in March, and a highlight of the conference was a keynote address from ISyE former chair Patti Brennan, now the director of the National Library of Medicine. WIHSE was



founded by 10 faculty members from across the university, including ISyE's very own Pascale Carayon (who serves as WIHSE's director), Oguzhan Alagoz, Jingshan Li, Nicole Werner and Doug Wiegmann. WIHSE seeks to become the premier research institute to revolutionize the patient experience, improve population health, control healthcare costs, and enhance clinician satisfaction.

I am also excited to announce that we have added a new faculty member to our ranks whose research area spans healthcare delivery and operations research. Stay tuned for full details in subsequent newsletters!

It isn't just healthcare where our department excels, but as you'll see in the newsletter, our faculty continue to be recognized as leaders in all their fields: manufacturing, analytics, human factors, and operations research. You'll read about our faculty who were recognized as

fellows in numerous professional societies (including IEEE and IISE) and who continue to accomplish groundbreaking research with grants from national and international agencies, corporations and foundations.

As you can see, we've had a great year. There's a lot happening, so stay tuned via Facebook and Twitter for all the latest ISyE news! And again, if you are ever in Madison, please stop by and say hello!

ON, WISCONSIN!

Sincerely,

Jeffrey Linderoth, Professor and Chair
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SMARTPHONE APP LINKS LOW-INCOME RESIDENTS WITH CRITICAL SERVICES

An ordinary late-January day in Madison—with temperatures in the 30s and about an inch of fresh snow—became memorable when four engineering and computer science students at UW-Madison received not one, but two pieces of good news: Their team was selected as a finalist in a design competition sponsored by the Human Factors and Ergonomics Society, and the students won their first-ever mini-grant from the Ira and Ineva Reilly Baldwin Wisconsin Idea Endowment.

The reason for these accolades was Health Links, a smartphone app the students had worked on since September 2016 to help connect low-income Madisonians with community resources, such as food pantries, shelters and health centers. Based on a user's geographic location and time of day, the app helps prioritize trips, minimize travel time and confirm business hours.

"The need for this kind of app is huge, especially since up to 70 percent of health outcomes have been attributed to influences outside traditional healthcare settings, such as social determinants of health," says Nicole Werner, an ISyE assistant professor and the students' mentor.

The background of the Health Links team is diverse: Nadia Doutecheva is a first-year PhD student in ISyE; Michelle Tong finished her undergraduate degree in biomedical engineering in May 2017 and is pursuing a master's degree before enrolling in medical school; Tom Martell, a December 2016 graduate, just started his ISyE master's program; and Ashish Shenoy graduated with a master's degree in computer sciences in May 2017.

Through a shared interest in human factors engineering—a field that applies our knowledge of human capabilities and limitations to systems design—the students' paths crossed at Werner's lab, creating the impetus to enter the student competition and apply for the mini-grant.

The project idea arose at the Wingra Family Medical Center on Madison's south side, where Tong was volunteering at the time. The clinic provides federally supported medical care to low-income residents, in partnership with the UW-Madison Department of Family Medicine and Community Health.

"I have always been interested in primary care and public health," Tong says. "Making it easier for the Wingra clinic's patients to connect with local resources for staying healthy and completing daily living tasks was an important incentive for developing the Health Links app."

By interviewing the clinic's social workers and several food pantry managers, the students assessed the currently available tools for locating community support services and identified areas for improvement.

The nonprofit organization Porchlight also was critical for the project's success. It provides temporary housing services

to Madison's homeless population of more than 3,000 and has a history of collaborating with UW-Madison students. With Porchlight's support, the team enlisted four volunteers—two "seeking" users in need of services and two "connecting" users, such as case managers, who help others find resources—to develop a Health Links prototype.

Applying the user-centered design techniques they had learned in class, the students outlined programming tasks for computer scientist Shenoy. Since smartphone ownership varies widely by income and age, they developed a mobile-enabled website that can be accessed from any internet browser—freely available at most public libraries—or downloaded as a smartphone app.

For Doutecheva, the project was something of an eye-opening experience. "I was very surprised at the disparity between the university campus and the rest of Madison," she says. "Having just recently moved here, I wasn't aware of the significant homeless population until we started this project."

The main goal of Health Links is to match a user's needs—for food, shelter, a shower, child care, transportation, job search assistance or skill-building—with community resources that can meet these needs at the time and place where they arise, and to provide Google Maps directions for reaching them. A future goal is to generate a "best fits" list based on previous searches of a demographically similar group of users.

For the student design competition, the team presented Health Links at the Human Factors and Ergonomics Society spring 2017 conference in New Orleans. Despite not winning first prize, they greatly valued the constructive feedback from academic and industry professionals. With the new Baldwin mini-grant, the students will expand Health Links to Milwaukee, a much larger city with different demographics that will require the support of new partner agencies.

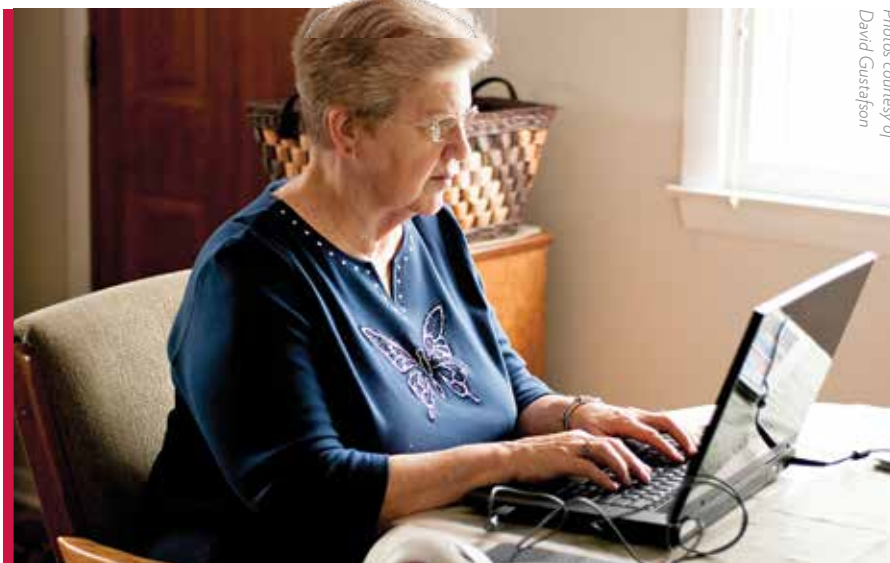
The students are embracing these challenges. "This is the kind of work we hope to be doing for a living," say Tong and Doutecheva. "Learning how to apply human factors engineering principles to a real-world problem is a valuable job skill as well as a rewarding experience."



The Health Links team includes (from left): Michelle Tong, Ashish Shenoy, Tom Martell and Nadia Doutecheva. ▶

IMPROVING QUALITY OF LIFE:

Helping older adults manage multiple conditions



Photos courtesy of
David Gustafson

An electronic health support system may help older adults manage multiple chronic health conditions by motivating them, connecting them with support groups and helping them cope with symptoms.



David Gustafson

The National Heart, Lung and Blood Institute has awarded a \$4.2 million grant to engineering, medical and communication researchers at UW-Madison to help adults over the age of 65 manage multiple chronic health conditions.

Among Medicare beneficiaries, 65 percent have at least three of these conditions and 23 percent have five or more; this subset of patients accounts for a stunning 90 percent of Medicare spending.

In partnership with patients and primary care providers, the researchers will develop an electronic health system enabling adults to self-manage their symptoms. The goal is to improve their quality of life, reduce physician burden, and save money, says principal investigator David Gustafson, a professor emeritus of ISyE and director of the Center for Health Enhancement Systems Studies.

"We will develop a new e-health intervention called Chronic Condition Health Enhancement Support System, or C-CHES," Gustafson says. "It builds upon the success of our previous CHES applications for conditions like cancer, asthma and alcoholism, which has been proven in 15 randomized clinical trials. Using the same gold standard, we will evaluate the benefit of adding C-CHES to 'treatment as usual' for multiple chronic conditions."

In collaboration with Randall Brown, an associate professor of family medicine and community health at UW-Madison, Gustafson will recruit 330 older adults diagnosed with at least three of the following conditions: hypertension, hyperlipidemia, diabetes and osteoarthritis.

The researchers will monitor the adults for 18 months, directing half of them to use C-CHES and the other half to review websites related to their conditions, in addition to receiving their usual medical care. C-CHES aims to boost users' intrinsic motivation and coping competence through web-based support and access to social networks of patients with similar health conditions.

The new project continues a previous collaboration between Gustafson and Jane Mahoney, a professor of geriatrics at UW-Madison, on the Elder Tree system, which helps older adults decrease the risk of falls and reduce loneliness and isolation. Under the name "Elder Tree Wisconsin," the system is freely available in 53 of Wisconsin's 72 counties.

Unexpectedly, Elder Tree users also reported a dramatic reduction in the number of medical symptoms and physician visits, motivating the research team to implement a direct link to healthcare providers in C-CHES. "When a user's self-reported data indicate a worrisome change in their health status, the online system informs the clinical team and provides an up-to-date summary of the patient's symptoms over time," Gustafson explains.

By connecting older adults with their primary care providers, Mahoney says, C-CHES will facilitate shared goal setting, health tracking and symptom communication, with the ultimate goal of improving health.

The grant also continues a collaboration with Marie-Louise Mares, director of the UW-Madison Center for Communication Research and professor of communication arts, who brings a wealth of experience in designing technology for both children and older adults to the project.

The A-CHES support system for alcohol use disorder is being used by more than 6,000 patients in the United States, New Zealand and Australia, with that number expected to increase to 10,000 by the end of

"We have to find a way to support patients during the high-risk times right before and after they receive medical care."

2017, Gustafson says. It is one of 11 finalists for the Harvard Kennedy School's 2016 "Innovations in American Government" award.

The C-CHES project hopes to achieve similar success. "To control healthcare costs, we expect to see a continued decrease in inpatient and increase in outpatient service use, which means we have to find a way to support patients during the high-risk times right before and after they receive medical care," Gustafson says. "I think that's where our technology can make a significant difference."

With a company that has grown from three employees in 1979 to 9,700 today—thanks to its information technology, which stores the electronic health records of half the U.S. population—Judy Faulkner knows a thing or two about what it takes to transform healthcare systems. “IT is like the central nervous system of organizations,” says Faulkner, founder and CEO of Epic Systems of Verona, Wisconsin. “It helps define how they work.”

Technology is also at the heart of the Wisconsin Institute for Healthcare Systems Engineering (WIHSE)—a new effort at UW-Madison that director Pascale Carayon hopes will become Wisconsin’s next key player in transforming the way healthcare is delivered in this country.

The institute capitalizes on a unique partnership among the College of Engineering and its Grainger Institute for Engineering, and the Schools of Medicine and Public Health, Nursing, and Pharmacy. Along with industry partners, researchers in the institute aim to develop healthcare systems that revolutionize the patient experience, improve population health, control healthcare costs, and enhance clinician satisfaction.

“There aren’t many campuses in the country that have strength in engineering, medicine, nursing and pharmacy,” says Carayon, the Procter & Gamble Bascom Professor in Total Quality in ISyE. “We have been building transdisciplinary collaborations between these four entities for years. Taking advantage of this unique crossroads, we hope to become a national model for an institute of this kind.”

In realizing their vision of transforming healthcare through engineering, institute researchers hope to reduce preventable medical errors, which are the third-leading cause of death after heart attacks and

NEW ACADEMIC-INDUSTRY EFFORT AT UW-MADISON AIMS TO IMPROVE HEALTHCARE THROUGH ENGINEERING

cancer; increase the number of Americans, beyond today’s 55 percent, who receive their recommended care; control the growth of healthcare costs, which account for nearly 18 percent of the U.S. gross domestic product; and reduce physician burnout, reported by 38 percent of practitioners.

Central to these overarching goals is the idea of modeling what health systems engineers call the “patient journey.” “We don’t just want to understand what happens when patients physically interact with their healthcare providers,” Carayon explains. “We want to build a system that supports ongoing communication between these partners in care, especially when they are distributed over space and time and affiliated with several distinct organizations.”

Carayon began to lead a working group of UW-Madison professionals charged with developing the institute’s mission in fall 2015. Following two roundtable meetings, WIHSE became official at its March 2017 inaugural conference, held on the UW-Madison campus with speakers—including Epic’s Faulkner—that represented the four academic partners as well as private industry, federal sponsors and healthcare-focused nonprofit organizations.

Keynote conference speakers were Carolyn Clancy, deputy undersecretary for health for organizational excellence at the Veterans Health Administration, and Patricia Flatley Brennan, director of the National Library of Medicine and former ISyE professor.

Industry partners interested in joining the WIHSE research consortium, which will provide access to students and a mechanism for contributing to the institute’s research agenda, can contact Carayon at pcarayon@wisc.edu.

MORE:

www.engr.wisc.edu/new-academic-industry-effort-uw-madison-aims-improve-healthcare-engineering/



Pascale Carayon



Photos: Stephanie Precourt

CLASS HELPS STUDENTS TACKLE REAL-WORLD DESIGN PROBLEMS WITH CONFIDENCE



Taking the “senior design project” class, better known as ISyE 450, is a requirement for graduating with a bachelor’s degree in ISyE. As a capstone course, it challenges teams of seniors to design a system, component or process that meets an external client’s needs while satisfying real-life constraints, such as cost, sustainability or safety.

Each year, the student teams—typically including four members—also compete for the Ratner Award, a cash prize for the three best senior design projects. The students presented their projects to department chair Jeffrey Linderoth and a panel of faculty members in January 2017.

The first prize (\$1,500) went to the project, “UW Health blood pressure visit improvement,” with team members Katie Ruge, Katie Bluske, Robyn Sreenivasam and Sherry Gao. The students designed a process that made nurse visits for patients on blood pressure-regulating medication more efficient by eliminating redundant information and standardizing follow-up communications with both the patients and their treating physicians. The students tested their new workflow design at several UW Health clinics, with nurses reporting not only a lower average task completion time, but also greatly reduced variation. “We were excited that our procedure was actually tested before the semester was over, since that was a pretty ambitious goal,” Ruge says. “Learning whom we needed to get on board to make this a sustainable solution for the long term was really valuable. We are hopeful that our new procedure will be implemented at many of the UW Health clinics that specialize in long-term blood pressure monitoring.”

The second prize (\$1,200) went to the “Madison-Kipp Corporation facility layout project,” with team members Nick Marks, Nate Renner, Carter Ziemann and Hailey Rowen. Madison-Kipp produces aluminum die cast components for industrial and transportation clients and recently completed a 90,000-square-foot expansion of its Sun Prairie facility. The students used a ranking tool to identify the company’s top criteria for designing the new space. The final layout maximized space use, included ergonomic workspace designs, and enabled an efficient flow of materials. This will improve operator safety while allowing for increased business in the future. “Our most important lesson learned was to remain flexible throughout the design process since criteria and project constraints changed over time,” Marks says. “We also realized the importance of developing relationships with the entire team of employees who will use the space, not just the main project sponsor, and of establishing credibility early on.”

The third prize (\$900) went to the project, “Verona clinic telephone response system,” with team members David Zhou, James Curland, Jackson Miller and Randall Pulfer. The students were tasked with raising the family medicine clinic’s percentage of patient calls answered within 20 seconds; a more-than-20-second wait increases the likelihood of abandoned calls, reducing patient satisfaction rates. The team developed a new staff incentive program and a streamlined process that routes all incoming calls to the call center first, only redirecting to clinic receptionists if both call center agents are busy. Pilot testing indicated a significant improvement toward the UW Health organizational standard. “Doing contextual interviews with the receptionists helped us understand the process we were asked to improve, prior to collecting and analyzing the quantitative data,” Zhou says. “At the end of the project, we found that a data-driven solution really helped convince our client that our proposed improvement was effective and reliable.”

ISYE STUDENTS PRESENT RESEARCH PROJECTS

In April 2017, several students mentored by Assistant Professor Nicole Werner were among hundreds of undergraduates who participated in the 19th annual UW-Madison Undergraduate Research Symposium. One student team also presented its work at the Improving Primary Care Through Industrial and Systems Engineering (I-PrACTISE) conference hosted by ISyE and the Departments of Family Medicine and Community Health, Medicine, and Pediatrics.

At both events, Rachel Zenker, a junior in ISyE, and Connor Pardell, an MBA student in the Wisconsin School of Business, presented their analysis of the burdens experienced by informal (unpaid, nonprofessional) caregivers of about 5.3 million patients diagnosed with Alzheimer’s disease or related dementias. These caregivers invest an estimated 18 billion hours of work per year, at a price tag of up to \$218 billion in caregiving costs, lost productivity, medical and institutional care. The students interviewed nine informal caregivers to develop a better understanding of their typical workload and the many challenges they experience every day. This insight will inform the next step of designing a technology-based support system targeted to this audience.

For the commercialization potential of this innovative support system, Zenker won a cash prize called the Undergraduate Discovery to Product (D2P) Commercialization Award.

Tom Martell, who is pursuing an ISyE master’s degree, and Anna Fulton Jolliff, who is enrolled in a counseling psychology master’s program, presented a design project focused on personal



Connor Pardell and Rachel Zenker

health information management. From interviews and virtual home observations, the students learned how patients personalize their home environment, available technology, and data storage tools to manage their health information while meeting their needs for privacy and security. Since the process can be burdensome, the students hope to design a secure and easy-to-use health information management system that incorporates what they have learned about the patients’ needs and interests.

Michelle Tong, a senior in biomedical engineering who is mentored by Werner,

As a specialty training program, the ISyE department was ranked eighth in the nation in the 2018 edition of U.S. News & World Report's "Best Graduate Schools."



Associate Professor **Laura Albert** received the college's Harvey Spangler Award for Technology-Enhanced Instruction, in recognition of innovative teaching and learning practices. Albert's research on the March Madness basketball brackets was featured in multiple regional print and broadcast media outlets.



Proctor & Gamble Professor in Total Quality **Pascale Carayon** was included on Becker's Hospital Review list of 50 experts in patient safety. As the only engineer on the list, she has received this honor for three consecutive years. She also became the leader of the Grainger Institute for Engineering's newly established smart and connected healthcare thrust.



Professor **Jingshan Li** was named a fellow of the Institute of Electrical & Electronics Engineers (IEEE), in recognition of his contributions to the field of manufacturing system automation.



Robert Ratner Chair **Raj Veeramani** received \$410,000 from Toyota North America to develop analysis methods for Internet of Things-enabled service systems. Faculty members **Shiyu Zhou** and **Kaibo Liu** are co-principal investigators.



Professor **Shiyu Zhou** was named a fellow of the Institute of Industrial and Systems Engineers, the world's largest professional society dedicated solely to the support of industrial and systems engineering.



ALUMNI NEWS

Jeff Roznowski (BSIE '80) received the Wauwatosa 2016 Distinguished

Citizen Award for his significant voluntary contributions to community life in Wauwatosa, Wisconsin, where he's lived for 34 years. He has founded and chaired several charity events, assisted with renovation projects, started a bike sharing program and raised more than \$500,000 for various causes and organizations.

Doctoral student **Raed Al Kontar** received a teaching assistant award for "Early Excellence in Teaching" from the UW-Madison Graduate School. The award recognizes exceptional teaching by graduate students across campus.

Megan Sweet was one of 15 UW-Madison undergraduate students to receive a Wisconsin Idea Fellowship, sponsored by the Morgridge Center for Public Service to address needs identified by community partners. Sweet will work with four other students and a nonprofit organization to implement solar technology for lighting and power applications in rural Africa.

Graduate and undergraduate students **Tianing Chen, Rachel Zenker, Ashish Shenoy** and **Connor Pardell**—all of whom are mentored by Assistant Professor Nicole Werner—received the "Best Social Entrepreneurs" award for their HelpCare Connect project at Transcend Madison. The event, created by the Transcend Engineering student organization, is UW-Madison's first-ever student-led innovation competition.

also studied personal health information management in someone's home, with a focus on patients with chronic diseases. For this audience, she identified several overarching strategies that should inform the design of consumer health IT applications, whose goal is to improve both medical outcomes and the healthcare decision-making process using electronic information and communication.

The research presented by Martell, Jolliff and Tong is part of the vizHOME project at the Wisconsin Institute for Discovery, which employs intensive home-based interviews and specialized imaging techniques to help design computer tools that support health practices in the home.

For I-PrACTISE, a team including Rachel Zenker; Nadia Doutcheva, who is pursuing a doctoral degree in ISyE; and Sai Suraj Kandukuri, a 2016 UW-Madison biochemistry graduate, responded to the organizers'

challenge to student participants to improve support for shared decision making.

For this task, the students chose a hypothetical 68-year-old man with diabetes, high blood pressure, osteoarthritis and depression who is considering prostate-specific antigen (PSA) screening for prostate cancer. The PSA test is controversial among clinicians: While it is simple, inexpensive and has the potential to detect a malignant tumor early enough to be treated successfully, a positive result can be misleading and result in unnecessary treatment if the tumor is benign.

In response to the organizers' challenge, the students developed PSAid, a web-based tool patients could use to verify clinical information from their electronic health record and to identify and rank their healthcare goals. The tool then combines the information into

a one-page personalized report that patients and their physicians can review and discuss to make a shared decision about PSA screening.

Doutcheva, Kandukuri and Zenker won the Ben-Tzion Karsh 2017 honorable mention award for their successful participation in the I-PrACTISE challenge.



The I-PrACTISE challenge team (from left): Sai Suraj Kandukuri, Rachel Zenker, Nadia Doutcheva received an honorable mention award.

SMART EQUIPMENT WILL MANAGE ITS OWN MAINTENANCE



Kaibo Liu

The number of devices connected to the internet—ranging from “smart” home appliances to health and fitness sensors—is predicted to increase from about 25 billion today to one trillion by 2025. But making sense of this highly interconnected data-rich world, which is enabled by “Internet of Things” (IoT) technology, requires much more than simply installing a few sensors.

“The IoT technology has little value by itself,” says Assistant Professor Kaibo Liu. “You create value by analyzing and interpreting the data in the context in which they are generated.”

In order to advance these analytic capabilities, the U.S. Department of Defense Office of Naval Research recently funded Liu’s research on IoT-enabled condition-based maintenance, diagnosis and prognostics for Navy equipment.

The U.S. Navy hopes that a growing number of sensors—measuring conditions like temperature, pressure and turbine vibration—will better predict the degradation of ships and other equipment over time. With continuous data collection, analysis and visualization, the Navy can design better maintenance schedules to reduce costs and prevent catastrophic failures, increasing the safety of the sailors and staff who operate or rely on the equipment.

But since the research is fundamental, the applications for the statistical methods Liu will develop don’t end with the Navy. The broader goal of the four-year project, which is supported by a total of \$275,000, is to devise novel methods for analyzing any continuously generated data from multiple sensors in real time. This will address shortcomings of existing methods that have focused on a single sensor, or on data collected at a limited number of discrete time points.

“Think of your car maintenance schedule,” Liu says. “The common recommendation to get a check-up and oil change every 3,000 miles or every three months could become much more precise if road conditions, driving style and other information about the specific car, driver and external environment were taken into account. This can be accomplished by analyzing the data from a variety of sensors installed on the car.”



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