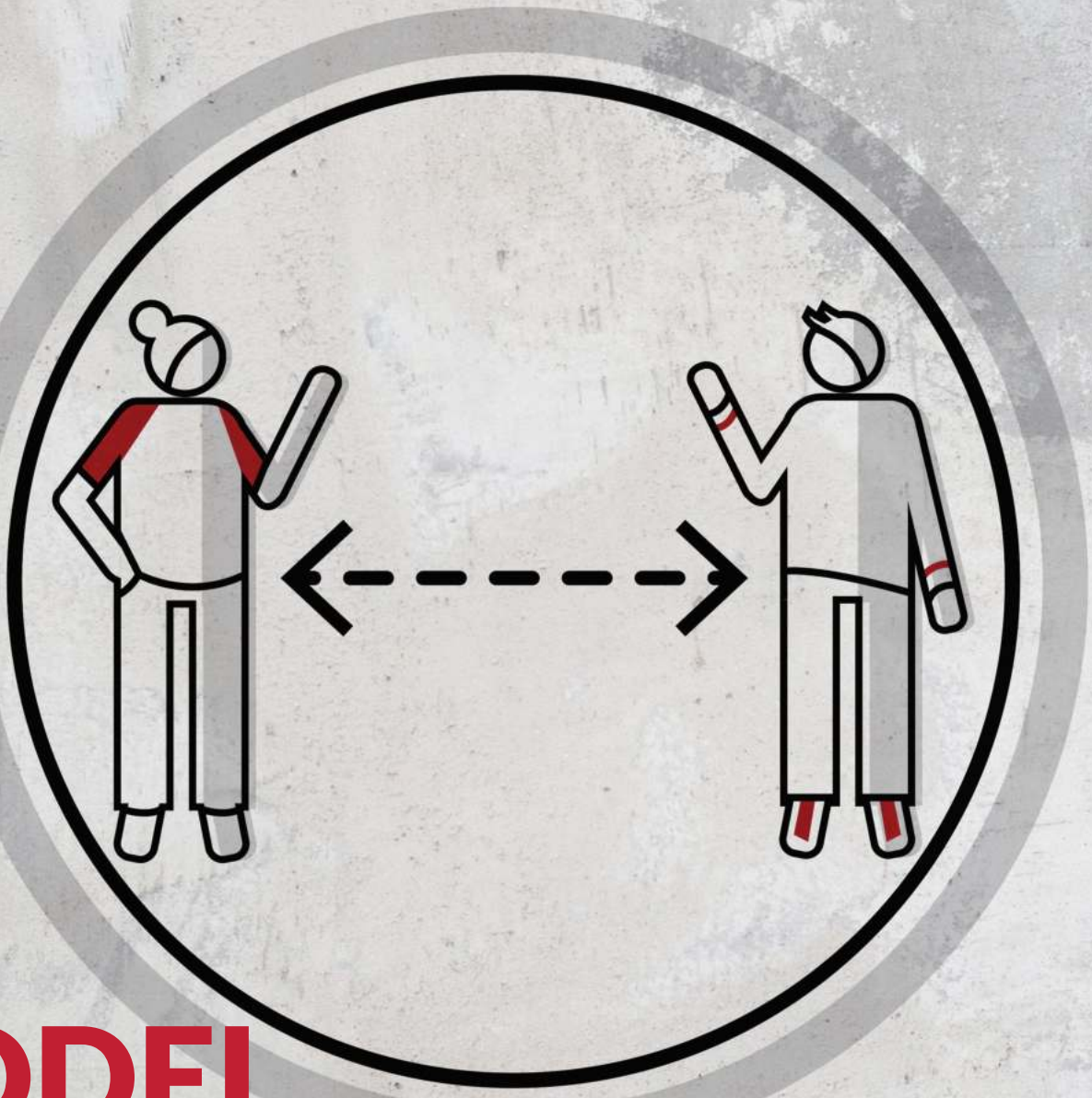
UNIVERSITY OF WISCONSIN–MADISON
COLLEGE OF ENGINEERING

SPRING 2021 NEWSLETTER

INDUSTRIAL AND SYSTEMS ENGINEERING



MODEL RESPONSE

Computational work informs public health policies

Greetings!

It's hard to believe that we have been adapting to the challenges presented by the COVID-19 pandemic for a full year now. We've gone to great lengths to serve our students from all over the world during this trying time, while continuing to pursue our research that creates and applies industrial engineering knowledge for the public good. Our work has kept us busy, and we're proud of what we've achieved, some of which is highlighted for you in this newsletter.

Our students never cease to amaze and impress us. ISyE student groups have remained active throughout the pandemic, as evidenced by the numerous awards various chapters received at their fall conferences. Additionally, individuals have been recognized at the very highest levels for their work, like PhD student Renee Greene, who has received the 2021 International Ergonomics Association's K.U. Smith Student Award.

Our students aren't the only ones receiving recognition. Professor Laura Albert has been named a fellow of the American Association for the Advancement of Science, and Assistant Professor Gabriel Zayas-Caban received the early career award from the Minority Issues Forum of the Institute for Operations Research and the Management Sciences (INFORMS).

The pandemic hasn't slowed down our world-class faculty in their research, either. With active grants across a wide range of research interest areas, our faculty members are busier than ever. In fact, our department's faculty are currently ranked first in the nation in the Faculty Scholarly Productivity Index (FSPI) produced by Academic Analytics. Our operations research and health systems engineering experts have been called on frequently over the past year to apply their research to pandemic-related challenges, and they have contributed significantly to identifying ways to battle the spread and collateral effects of COVID-19.

This spring also brings significant changes to the faces in our department. Longtime professor and former department chair Vicki Bier recently retired, and I will be stepping down as chair in a few short months. Professor Laura Albert will be taking the reins, and I assure you, the department will be in extremely good hands under her leadership.

We are grateful for your continued interest in, and support of, our department. I hope that, in the near future, we can be together on campus. Until then, please feel free to reach out to me by phone or email. I would love to connect with you personally.

On, Wisconsin!

Jeffrey Linderoth
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FINE FELLOWSHIP

ALBERT EARNS AAAS HONOR

Professor Laura Albert jumps at opportunities to use her research to inform public policy and to share her work beyond academic circles.

Her efforts earned her top recognition from the American Association for the Advancement of Science (AAAS), which elected her a fellow as part of its 2020 class.

Albert, who is also a Harvey D. Spangler Faculty Scholar, received the honor for her distinguished contributions to the application of operations research methodologies to public policy, and for communicating her research to the public.

Through her operations research, she applies optimization approaches to challenges in critical public sector infrastructure, such as homeland security, emergency response and cybersecurity. Albert uses Twitter and her blog, Punk Rock Operations Research, to explain her work. She's also written op-ed pieces in publications such as *The Hill* and *Fox News* and shared her expertise in numerous media interviews.

"It's important that we look beyond our discipline and make a difference in the world and think about what impact our research has," she said in an AAAS member spotlight.

The fellowship honor, dating back to 1874, is bestowed annually on members of AAAS who are nominated by their peers and recognized for their efforts to advance science and society.

SUPPORT ISyE

ENGINEERING FORWARD

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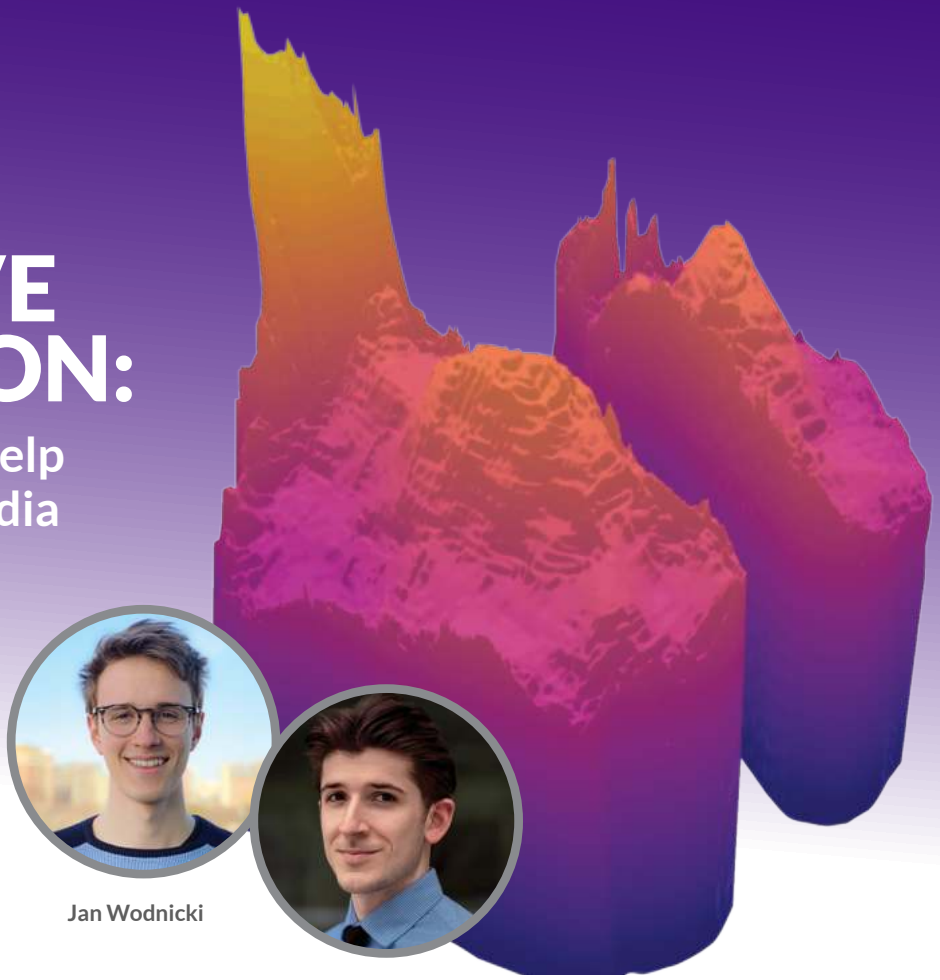
PREDICTIVE PREVENTION:

Undergrad works to help diabetic patients in India



Jan Wodnicki

Thor Larson

For several thousand dollars, diabetic patients can purchase a mat capable of thermally imaging their feet to preemptively detect ulcers and transmit data for remote monitoring.

The technology is impressive. But the cost means it's also out of reach for most patients and clinics in low-resource settings across the globe, where diabetes is most prevalent.

"Those kinds of resources are just not available to many people in India," says ISyE undergraduate student Jan Wodnicki, who's working on a lower-cost, portable alternative, with India as the focal point. "They're kind of left out of this 'big medicine.'"

Wodnicki, a junior from Brookfield, Wisconsin, received a Wisconsin Idea Fellowship to support the project, which is a collaboration with biomedical engineering student Thor Larson. It's a blend of medical device prototyping and advanced data analysis.

"We see it as kind of a rapid triage solution, where instead of having everyone assessed by a physician, you would take a picture of their feet and they would get some kind of risk score. If they were deemed low risk, they would be sent back home and if not, they would proceed further with clinical examination," says Wodnicki. "The motivation is that there is such a high prevalence of diabetes in India and overwhelming demand at hospitals."

The idea emerged from the Department of Biomedical Engineering's undergraduate design curriculum via alumna Kayla Huemer (BSBME '18), who worked on a device prototype as a Fulbright Scholar in India but wanted to incorporate machine learning for data analysis.

Wodnicki and Larson focused more on the mechanical design of the device during their semester together in the biomedical engineering design program. Wodnicki subsequently switched his major, but the two have continued the effort and turned their attention to the data science side of the project.

They've created an app to streamline the data collection process when taking images, allowing users to quickly analyze the data. And, with guidance from ISyE Assistant Professor Justin Boutilier, Wodnicki and Larson have used data from Huemer's work in India to develop algorithms that can identify ulcers before they break through the skin. The two took Boutilier's *Machine Learning in Action* course during the fall 2020 semester, allowing them to tinker with different methods of data analysis.

They're currently able to identify, with roughly 89% accuracy, whether a patient has developed an ulcer based on thermal imaging data—and hope to push that rate above 95%.

To achieve that—and create an automated process to quickly generate a risk score for each patient—they say they simply need to collect more data in the field, which would allow them to use more advanced machine learning techniques broadly known as deep learning to refine their algorithms.

The COVID-19 pandemic shelved their plans to travel to India in summer 2020, but they're hopeful they'll be able to go once conditions improve around the world and travel is less restricted.

"I'll be ready to when we're able to," says Wodnicki.

RETIRING BIER LEAVES LEGACY OF RELEVANT RISK RESEARCH

Midway through graduate school at Massachusetts Institute of Technology, Vicki Bier encountered a crisis of confidence. The aspiring risk analysis researcher found herself lacking the inspiration to devour the latest journal articles on the inner workings of algorithms—and worried that her disinterest was a warning sign, revealing some personal shortcoming.

She stepped away from school for a year, taking a job at the consulting firm Arthur D. Little to work on risk analysis in the chemical and petrochemical industry. Exploring tangible problems like the risk of failure at a chemical plant and following high-profile questions about nuclear power risk in the news awakened a realization in Bier.

"I discovered that once I was working on something related to policy, I no longer felt uninterested," she recalls. "A lot of operations research really is about efficiency, and that was just never as interesting to me. It's important; it's good that there are plenty of people doing it, but it was not as interesting to me as something where I could see a broader societal relevance."

Bier has carried that fervor for investigating timely topics with her ever since, including during her 30-year career as an ISyE professor at UW-Madison. She retired in January 2021.

Since arriving at UW-Madison in 1990 after working as a risk analyst at a consulting firm for clients in the nuclear power industry, Bier has tackled current and relevant issues such as homeland security resource allocation, the effects of deregulation on nuclear power safety, and pandemic preparedness.

"A lot of my interests have been drawn from the news," she says. "I have had an eye for problems where I thought progress could be made reasonably quickly, either because not enough people were thinking about something or because I had a different angle on how to think about it."

Former PhD student Jun Zhuang (PhD '08), now a professor at the University at Buffalo, has modeled his own decision analysis course after Bier's. Zhuang, along with fellow PhD graduate Chen Wang (PhD '13, now an associate professor at Tsinghua University in China), organized a 2017 conference in China to honor Bier's legacy and work in risk and decision analysis.

"She's a lifelong mentor for me," says Zhuang.

Likewise, alumnus Jon Welburn (BS '10, PhD '16), now an operations researcher at the policy think tank RAND Corporation, remains in frequent contact with Bier; in fact, the two are collaborating on a paper examining systemic risks in the wake of the COVID-19 pandemic. Welburn started working with Bier as an undergraduate student and says she was the reason he stayed at UW-Madison to pursue his PhD, even though his focus on economics problems was outside of Bier's established lines of research.

"She was quite supportive in pushing us to do the work that we wanted to," he says.

Bier, who's supervised 20 PhD students in total (plus one still in progress), points to watching her first PhD advisee, Naceur Azaiez (PhD '93, now a professor at the University of Tunis in Tunisia), as one of her enduring professional memories.

She remembers feeling a sense of trepidation after turning down several academic jobs while working in consulting. She's grateful UW-Madison has proven her instincts correct.

"The thing I've appreciated most about being here at Wisconsin is the level of freedom that faculty have to choose what they want to work on," she says. "I never felt constrained. There were a lot of people doing very interesting, eclectic, interdisciplinary work, and that was really important to me."

LOCAL LOOK

Alagoz's region-specific COVID modeling shows effect of social distancing measures

As the COVID-19 pandemic first took hold in regions across the United States in spring 2020, governors, mayors and local leaders hoping to quell the spread of the virus turned to the only actionable defenses available at the time: They closed schools and businesses, banned mass gatherings, issued stay-at-home orders and enforced other social distancing measures.

A study led by Proctor and Gamble-Bascom Professor Oguzhan Alagoz and published in the *Annals of Internal Medicine* quantified the region-specific impact of social distancing measures on the COVID-19 caseload in three distinct areas: New York City, the Milwaukee metropolitan area and Dane County in Wisconsin.

Using aggregated cell phone mobility data as a way to track how people complied with social distancing policies, Alagoz and collaborators from the UW-Madison School of Medicine and Public Health created a computational model to simulate COVID-19 cases based on when social distancing directives were implemented and eased, as well as how diligently people adhered to those orders.

The simulation showed social distancing measures wielded major influence on case numbers, though the impact varied markedly in different areas, even within the same state.

According to the researchers' model, the timing of implementing social distancing measures was particularly crucial in New York, where the state restricted mass gatherings March 12, 2020, and introduced increasingly stringent measures over the following 10 days.

However, according to the model, had the state acted one week earlier, the number of cases in New York City would have been 80% less (41,366 instead of 203,261) by the end of May; conversely, a week's delay would have increased the caseload nearly seven times, to more than 1.4 million. The impact of the timing wasn't as dramatic in Dane County, where a one-week delay would have increased its number of cases 36% by the end of July.

"Everybody knows, qualitatively, social distancing measures have made a difference, but I think this is one of the most accurate estimates of how much of a change they really led to," says Alagoz, an expert in infectious disease modeling. "In places where you have high population density and a lot of movement in and out of the area, the impact of social distancing is significantly greater, compared to other places. Wisconsin, for example, implemented the same social distancing measures statewide, but the impact was different in Dane County, Milwaukee and other areas. Our model actually is able to tell us this quantitative estimate of how much of a difference we are going to see from one region to another."

Oguzhan Alagoz

The group's model took into account each region's demographics, infections imported from outside the area, asymptomatic transmission, age-specific adherence to social distancing rules, and limited availability of testing in the early months of the pandemic. Alagoz notes that a confluence of those factors drives infection rates in different areas, which demonstrates the need for region-specific modeling and policies.

Throughout the pandemic, Alagoz has worked closely with colleagues in the School of Medicine and Public Health and at UW Health to develop and refine models to aid health officials in Dane County and south-central Wisconsin. He has also shared his efforts with the Wisconsin Department of Health Services.

He says the work has been among the most challenging experiences of his career.

"We spent five years building a model for hospital-acquired infections, two years building a model for tuberculosis transmission, and only two weeks to model COVID-19," he says.

KNOWLEDGE RETENTION

Undergraduates sharpen skills while helping rural school district

When recent graduate Bailey Benck worked at a manufacturer in Waukesha, Wisconsin, as part of a cooperative education program, he found himself applying process improvement techniques to problems straight from his industrial engineering courses.

But when Benck and three classmates from ISyE 515: *Engineering Management of Continuous Process Improvement* took on a project during the fall 2020 semester to improve teacher retention and recruitment in a rural school district in central Wisconsin, they discovered a very different way to apply those concepts.

Bailey Benck

"In class, we don't talk about how these tools can be applied to a school district," says Benck, who graduated in December 2020. "Our project really forced us to establish that deep understanding of the tools we learned and developed, and how to use and apply them to a little bit less traditional situation."

Benck and groupmates Joshua Fernandez, Dom Maderal and Reid Parks sharpened their command of industrial engineering tools while delivering actionable recommendations for the Adams-Friendship School District, which serves roughly 1,500 students and sits an hour-and-a-half drive north of the UW-Madison campus. The project was part of UniverCity Alliance, a UW-Madison research and outreach effort that connects faculty, staff and students to tangible issues facing local communities.

Teacher retention was a particular issue for Adams-Friendship in 2018 and 2019, when the district lost roughly 20% of its teaching staff each summer. That made it the top priority for Adams-Friendship District Administrator Tom Wermuth when he took over in 2019.

To identify underlying causes, the students gathered input from district administration and surveyed the full teaching staff. Then, using industrial engineering methodologies, they distilled those responses into unifying themes and set about generating ideas for tactics to address those issues, balancing what could be done in a semester with the potential impact.

In the end, their recommendations included new leadership training, school and district value-defining workshops, goal-setting activities and streamlined internal communications. Empowering teacher voices to enhance their sense of investment in the district was a common thread. The qualitative nature of the project and the complexities of working on, as Benck puts it, "one big people-oriented system" necessitated multifaceted strategies to encourage long-term change.

"Culture change work is hard," adds Maderal.

But the students say tackling such a challenging assignment in the course, taught by senior lecturer Terry Mann, has given them enduring lessons to carry forward into their careers.

"If you can get your hands dirty in a real system, especially a nontraditional engineering environment, it really puts your skills to the test," says Parks, who also graduated in December 2020. "This is going to help me in the real world—I won't say more than any of my other experiences at UW, because they'll all contribute—but this one's going to be a key to me succeeding in private or public industry."

Wermuth says the district is already implementing some of the students' suggestions.

"The students went above and beyond in providing us information and just a really different way to look at the problem that's occurring in our district and occurring in a lot of other rural districts across the state of Wisconsin," says Wermuth. "We're going to change some processes and practices that we have in the district to allow teachers more voice in the decision-making."

A student works during in-person learning at Adams-Friendship Elementary School. Photo courtesy Adams-Friendship School District.

Faculty News

Proctor and Gamble Bascom Professor Oguzhan Alagoz received a $2.4 million grant from the National Cancer Institute to apply mathematical modeling to the overdiagnosis of thyroid cancer. He is also part of a $9.1 million collaborative grant from the National Institutes of Health to use simulation modeling to examine precision breast cancer treatments and inform clinical policies.

Professors and Harvey D. Spangler Faculty Scholars Laura Albert and Jim Luedtke are using a $1.2 million grant from the National Science Foundation (NSF) to develop an optimization framework that can help organizations effectively and efficiently protect their information technology systems.

Associate Professor Kaibo Liu is using grants from the U.S. Department of Energy and 3M to apply a machine learning technique called transfer learning to nuclear reactor safety and maintenance and industrial manufacturing production systems, respectively. He also received a grant from the U.S. Army Engineering Research and Development Center to develop new artificial intelligence methods and tools to improve predictive maintenance of smart and connected systems. Liu won the Institute of Industrial and Systems Engineers' Innovations in Education Award.

David H. Gustafson Department Chair and Harvey D. Spangler Professor Jeff Linderoth earned a grant through the American Family Funding Initiative to apply integer programming methods to create algorithms that could be used to solve mixture matrix completion problems. Professor Jim Luedtke is a co-principal investigator.

Duane H. and Dorothy M. Bluemke Professor Robert Radwin is leading a project to bolster human and robot collaborations in the manufacturing sector through a $1.5 million grant from the NSF.

Recently retired Professor Vicki Bier received an NSF grant to test different strategies for incentivizing preemptive relocation in areas at risk for coastal flooding. Bier is also serving on a National Academies of Science, Engineering, and Medicine ad hoc committee applying risk analysis to the threats of nuclear war and terrorism.

Jane R. and Jack G. Mandula Assistant Professor Gabriel Zayas-Caban earned an early career award from the Minority Issues Forum of the Institute for Operations Research and the Management Sciences for his research and service.

Harvey D. Spangler Assistant Professor Nicole Werner landed a grant from the National Institute on Aging to further develop CareVirtue, a web and mobile app, to support family caregivers of individuals with Alzheimer's disease.

Professor Raj Veeramani received the E-Business Chair Professorship. Veeramani is executive director of the UW E-Business Institute and UW E-Business Consortium, connecting the university with industry.

Assistant Professor Justin Boutilier was named the Charles Ringrose Assistant Professor, supporting his work applying optimization and machine learning techniques to global health challenges.

Student News

PhD student Renee Greene was the 2021 recipient of the International Ergonomics Association's K.U. Smith Student Award.

Our INFORMS student chapter was selected as a winner of the INFORMS 2020 Student Chapter Annual Award at the cum laude level, while our student chapter of the Human Factors and Ergonomics Society received the organization's gold status.

Alumni News

We honored two outstanding alumni as part of the college's annual awards.

Jeffrey J. Rotsch (BS '72), retired president of worldwide sales at General Mills, received a Distinguished Achievement Award for his work driving global business success in the consumer foods industry.

James Tamplin (BS '06, MS '07), founder partner at Founder Collective and executive board member at Covid Act Now, received an Early Career Award for his efforts transforming mobile app development as cofounder of the startup Firebase.

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Mintz makes machine learning work for personalized healthcare

Leave it to an optimization researcher who specializes in healthcare to use county-level COVID-19 data to meticulously plot out a move from Atlanta to Madison, Wisconsin. That's precisely what Yonatan Mintz did ahead of his drive north in late summer 2020.

Mintz, who joined ISyE as an assistant professor after two years as a postdoctoral fellow at Georgia Tech, applies optimization and machine learning methods to tailor healthcare interventions to individuals. He says ISyE's strengths in optimization and health systems engineering, paired with its long track record of collaboration with medical researchers across the UW-Madison campus, makes it an ideal home for his work.

Yonatan Mintz

Mintz's research portfolio includes leveraging patient data to hone personalized health and wellness solutions through wearable technology, to refine drug dosing plans in intensive care units, and to better model the different variations of Parkinson's disease.

As a PhD student at the University of California, Berkeley, he developed the algorithm behind a fitness app that learned users' exercise and food preferences and then created goals suited to them. In a randomized controlled trial, the app outperformed Fitbit in spurring users to exercise more.

Mintz plans to continue creating models to promote health and wellness via mobile apps and wearable technology. He's also developing an algorithm to inform individualized dosing strategies for the blood thinner heparin. His work on Parkinson's disease involves both a model to predict different manifestations of the disease and methods to more clearly explain the factors behind a diagnosis.

"The thing that I find interesting is how do machine learning and optimization impact people? How can we use them to impact people for good? How do we understand the negative effects they have?" he says. "I feel like this is where I can make the most impact: these problems of human-sensitive machine learning and optimization and making sure that these algorithms work for us instead of the other way around."