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WORCESTER POLYTECHNIC INSTITUTE

SCHOOL *of* ARTS & SCIENCES

FALL 2023 ISSUE

Nobel Laureates Discuss mRNA's Future in Medicine at WPI's Nature Conference

Katalin Karikó, this year's Nobel Prize winner for discoveries that enabled the development of effective mRNA vaccines, and Phillip Sharp, who won in 1993 for his discovery of split genes, were among more than two dozen speakers who presented their visions for mRNA. The three-day event, held at WPI's Rubin Campus Center , drew representatives from Alnylam Pharmaceuticals, MassBio, Moderna, UMass Chan Medical School, and others, showcasing the booming life sciences sector in Central Massachusetts.

RESEARCH SPOTLIGHT

Biology Professor Investigates Primary Cilia for Insights Into Genetic Disorders

With over $564,000 in funding, Inna Nechipurenko, assistant professor of biology and biotechnology , will study primary cilia's critical role in human health, aiming to uncover their function's genetic basis and potential therapeutic pathways for genetic disorders.

Head of Data Science Receives IEEE Test-of-Time Award for Trailblazing Research

Elke Rundensteiner, the William Smith Dean's Professor in Computer Science and founding head of WPI's data science program , and her team received this prestigious award for their pioneering work in visual data analytics, which laid the groundwork for today's tools and techniques.

NSF Grant Winner Leads Cross-Functional Team to Explore Visual Cues in Math Learning

Backed by a $667,617 grant from the NSF, Erin Ottmar, associate professor of psychology and learning sciences , will collaborate with researchers from WPI, Virginia Tech, and Purdue University to explore how visual cues affect students' abilities to solve algebraic equations.

WPI Researchers—and a Robotic "Lizard"—Pave the Way for Safer Building Inspections

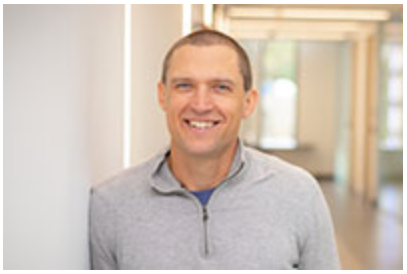
Using a $50,000 National Science Foundation (NSF) grant, an interdisciplinary team of WPI researchers and PhD students developed a lizard-like soft robot that can crawl into hard-

to-reach spaces in buildings—potentially revolutionizing worker safety and climate adaptation in cities.

FACULTY SPOTLIGHT

Reeta Rao, PhD, Named Head of Department of Biology and Biotechnology

A leader in molecular genetics and genomics with a focus on emerging infectious diseases, Rao is committed to developing and training the next generation of scientists. She joined WPI in 2004 as an assistant professor of biology and biotechnology and served as interim department head for the last two years.



Sam Walcott, PhD, Appointed Director of Bioinformatics & Computational Biology Program

After joining WPI in 2019 as an associate professor and Sinclair Professor of Mathematical Sciences, Walcott served as the associate program director in 2022–23. He will now succeed Liz Ryder as program director, bringing a wealth of experience to his new role.

STUDENT SPOTLIGHT

Bridging Art and Technology To Reach New Creative Heights

A practicing artist with exhibits at prominent galleries in Boston, Darren Cole combines his passions for art and technology as a PhD student in WPI's Interactive Media and Game Development program. He'll use his research

and artwork to help underrepresented communities.

ALUMNI SPOTLIGHT

How a Piano Prodigy Keeps One Foot in Music, the Other in Software Engineering

“Coding is just a form of composing,” says Sergio Salvatore ’02, senior director of engineering at Vimeo. After recording his first album at age 11 and touring jazz clubs as a teen, he majored in computer science and found a career in media technology—exemplifying how creativity transcends disciplines.

EVENT SPOTLIGHT

Faculty and Local Medical Experts Probe Into Potential Uses of AI in Healthcare

In a panel discussion about the intersection of healthcare and AI, experts from WPI and UMass Chan Medical School explored AI’s potential to expand access to quality care, diagnose and treat certain conditions, and improve health outcomes.

Part of WPI's ongoing "Critical Conversations" series, the discussion was a marquee event at this fall's Arts & Sciences Week , which also featured undergraduate student research presentations, musical performances, and a one-woman play.

NEWS SPOTLIGHT

Computer Science Professor Discusses AI's Future Role in Studying Depression

Erin Solovey, associate computer science professor, shared insights about the technology's ability to detect brain patterns specific to depression, explaining that advancements in machine learning could lead to tools that help monitor human health and well-being.

WPI and College of the Holy Cross Team Up To Offer Dual-Degree Programs

The collaboration will allow students to earn a bachelor's degree at Holy Cross and a master's degree at WPI in an accelerated 4+1 model, providing students with new educational pathways, strengthening ties between the two institutions, and fortifying Worcester's reputation in higher ed.

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Nobel Prize winner Katalin Kariko

Nobel Laureates Headline Nature Conference at WPI

"Cracking the Code: The Dawn of Nucleic Acid Medicines" considers state-of-the-art, future possibilities of RNA therapeutics; prestigious event highlights Central Massachusetts as an important biotech hub.

▶ LISTEN 00:00

BY: STEVE FOSKETT
PHOTOGRAPHY: MATT BURGOS

In the early 1990s, when the scientific community seemed skeptical of her belief that using the body's messenger RNA, or mRNA, to develop therapies to fight disease and treat conditions was a real possibility, Katalin Karikó turned to her own family for validation.

The biochemist and recently minted Nobel laureate relayed to a packed audience last week at WPI's Rubin Campus Center a story about trying to convince her husband, an engineer, and her 11-year-old daughter that mRNA would be the future of medicine.

She must have received the confidence boost she sought from that living room pitch—the Hungarian-born researcher's belief that the tiny strands of life's building blocks could one day be used to treat illnesses and vaccinate people from disease proved more than prescient.

Karikó was on the WPI campus as a keynote speaker at the Nature conference, a three-day event run by the family of prestigious scientific journals that drew scientists and researchers from around the world. Students and conference attendees crowded around her before her address, posing for selfies and getting her to sign copies of her book, *Breaking Through.*

Karikó and her colleague Drew Weissman—who met by chance while waiting to use a photocopier one day at the University of Pennsylvania–earlier this month received the Nobel Prize in Physiology or Medicine for their discoveries about how mRNA interacts with our immune systems. Their groundbreaking discoveries laid the foundation for rapid development of COVID-19 vaccines that saved countless lives and helped the world recover from a global pandemic.

While walking the conference audience through the dense science that has helped make mRNA therapeutics a reality in modern medicine, Karikó weaved into her remarks very personal elements of an unconventional career timeline marked by frequent rejection, constant struggle, and unwavering persistence that she hopes inspires the next generation of scientists.

She talked about how early proposals she crafted to look deeper into mRNA–the delivery system for genetic information encoded in DNA that leads to the production of proteins–went unfunded, and about how, very early, on she carried out the bulk of her research on her own, without an army of graduate and PhD students to help.

"I did the experiments," Karikó said. "I know what it takes."

Karikó said she didn't hold any grudges for having to wait for others to come around to her vision of how mRNA could be used as a therapeutic. Years of rejection didn't shake her confidence.

"It always made me work better," she said. "That's why I'm here."

Karikó wasn't the only Nobel laureate in attendance at the conference. Phillip Sharp, who won the prize in 1993 for co-discovering RNA splicing, spoke at the conference about the promise of RNA therapies for treating various conditions.

Sharp and Karikó were among more than two dozen speakers who shared insights during the conference including WPI's own Dmitry Korkin, the Harold L. Jurist '61 and Heather E. Jurist Dean's Professor of Computer Science. Korkin's presentation was on decoding the functional and structural impact of alternative splicing in human cells.

1993 Nobel Prize winner Phillip Sharp

The work being done on mRNA therapeutics is important for global health, but it's also becoming an economic engine in Massachusetts. Melissa Moore, chief scientific officer emeritus at Moderna, worked closely with Jean King, the Peterson Family Dean of Arts and Sciences at WPI, to bring the conference here. Moore said 750 biotech or bio-manufacturing companies are currently operating in the state, and they offer good-paying jobs that cater to a wide variety of skillsets.

King said bringing the Nature conference to WPI highlighted the university's strengths in the life sciences and reflected the sector's widening footprint in Central Mass.

"The Nature conference at WPI brought some of the most brilliant minds in the world under one roof for three days to share insights, engage with students, and to find out what the future holds for nucleic acid medicine," she said. "Having two Nobel laureates at the conference speaks to the intense interest in mRNA therapeutics and other cutting-edge approaches, but it also highlights the role this sector plays in the regional economy and at institutions like WPI."

WPI and local high school students got the chance to rub elbows with researchers and scientists from private industry and academia during the conference. Around 170 city high school students attended a career day, where they learned more about current research and career opportunities with representatives from Alnylam, MassBio, Moderna, UMass Chan Medical School, and others.

Moore said it's important to show students interested in STEM that there may be a career for them in biotech, regardless of where they're coming from.

"Having two Nobel laureates at the conference speaks to the intense interest in mRNA therapeutics and other cutting-edge approaches, but it also highlights

the role this sector plays in the regional economy and at institutions like WPI." »

Jean King
Peterson Family Dean of Arts and Sciences, WPI

"The idea is we need more people coming into the industry," Moore said. "And it's a terrific opportunity to try to correct some of the structural problems we've had in society, with underprivileged groups not being represented. It's about increasing the diversity. These are really good-paying jobs with incredible benefits. It's an opportunity to create generational wealth, which is what holds a lot of underprivileged groups back."

The idea of using nucleic acid medicine to treat, and even cure disease doesn't just live in theories and academic papers—it's already being done. Moore, who was part of the team that developed Moderna's COVID-19 vaccine, said the technology is being used right now in therapeutics, for example, that treat high cholesterol with a shot every six months, rather than a daily regimen of statins. She said there's much more coming, and it will be here sooner than you think. She said gene editing technology will allow for the development of personalized medicines, for example. Think of it as a custom-made cancer vaccine, unique to a single person.

"We're going to be able to cure disease that now, we are just able to treat their symptoms," Moore said. "That is very exciting."

The conference was organized and sponsored by Alnylam Pharmaceuticals, Moderna, UMass Chan Medical School, WPI, *Nature Biotechnology* and *Nature Immunology.*

Related Stories

Inna Nechipurenko to Explore Mysteries of Tiny Cellular Structures With Two New Grants

NIH and Charles H. Hood Foundation Support Research Aimed at Understanding the Role of Cilia in Neurodevelopmental Disorders

▶ LISTEN 00:00

August 23, 2023

It takes a powerful microscope to view the tiny cellular structures known as primary cilia that are at the center of Inna Nechipurenko's research.

"You can think of primary cilia as tiny antennae that project from the surface of nearly all cells in our bodies, and these antennae are absolutely essential for our cells to be able to communicate with each other and to collect information about their environment," says Nechipurenko, an assistant professor in the Department of Biology and Biotechnology. "Their critical importance for human health is particularly highlighted by the fact that people who have any defects in the function of these structures suffer from devastating genetic disorders, for which there is no cure."

Inna Nechipurenko

With nearly $564,000 in recently awarded funding, Nechipurenko is launching two projects that will investigate the genetic basis of primary cilia formation and function in nerve cells. These projects will provide the basic science foundation that is a necessary steppingstone for developing therapies.

The first project, funded with a three-year $363,984 grant from the National Institutes of Health, will determine how a gene called RIC-8 shapes primary cilia structure and function in neurons.

The second project, funded with a two-year $200,000 grant from the Charles H. Hood Foundation, will define the function of a human gene called *GNAI1* in primary cilia assembly. The project will also use the microscopic worm *C. elegans* as a tool to rapidly and systematically determine how patients' mutations in *GNAI1* affect the gene's function. *GNAI1* is a known risk gene for neurodevelopmental disorders.

Both projects build on Nechipurenko's research into the molecular machinery that is important for correct assembly and function of primary cilia in the nervous system.

"In the last 20 years or so, we came to appreciate how truly important cilia are for every aspect of human physiology," Nechipurenko says. "We literally see, smell, and hear through cilia. We have also learned a great deal about molecules that are at the core of these structures, but the functions of cilia in the brain remain a mystery."

Scientists first identified primary cilia in the 1800s but dismissed them as useless structures. That misconception changed after 2000 as researchers discovered the critical roles that cilia play in mediating cell-to-cell communication and linked cilia malfunction to a range of genetic disorders that include polycystic kidney disease, metabolic and cardiovascular diseases, and neurological conditions such as intellectual disability and autism spectrum disorder. More than 30 disorders and more than 150 genes have been linked to dysfunctional cilia.

"Although much progress has been made in the past 20 years to better understand all cellular roles that primary cilia play and why or how their dysfunction may lead to diseases, many questions remain," Nechipurenko says. "We are particularly excited to begin asking how cilia functions intersect with other aspects of neuronal physiology, and why it is so detrimental to neurons if cilia do not function just right."

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Elke Rundensteiner Receives the Prestigious IEEE Test-of-Time Award for Groundbreaking Visual Data Analytics Work

Department(s): Marketing Communications

October 17, 2023

Elke Rundensteiner, the William Smith Dean's Professor in Computer Science and Founding Head of WPI's Data Science Program, recently received the InfoVis 20-Year Test-of-Time Award from the Institute of Electrical and Electronics Engineers (IEEE) for her pioneering work on data visualization and visual analytics in 2003.

This award honors articles published at previous IEEE conferences, in this case in 2003, that have withstood the test of time by remaining useful 20 years later and that have had significant impact and influence on future advances within and beyond the visualization community, according to the award's organizers. Award selection is based on measures such as the numbers of citations, the quality and influence of its ideas, and other criteria.

Rundensteiner and her team, which included the late computer science professor Matthew Ward and former PhD students Jing Yang and Wei Peng, are being honored for their work on interactive hierarchical dimension ordering, spacing, and filtering for the exploration of high-dimensional datasets.

"I fondly remember my close research collaboration with my colleague Matt Ward over a 17-year time span from 1998 to 2014 that resulted in a series of 7 National Science Foundation (NSF) research grants and one National Security Agency (NSA) grant for our work at the intersection of visualization and data analytics," Rundensteiner said. "This allowed us to collaborate with countless joint PhD students, contributing cutting-edge advances to the then-newly emerging area of visual analytics, which led to this inspiring award. Matt was not only a creative thinker at the forefront of his time, he was a supportive colleague and generous friend and remains a true inspiration for me."

According to the award selection committee, the work that Rundensteiner and her team undertook presents a thoughtful, elegant, and powerful approach to managing the complexities of high-dimensional data and reducing clutter in visualizations such as parallel coordinates. The team's research provided insight by clustering the dimensions of high-dimensional data sets into a hierarchical structure (instead of just clustering the data itself), which then can be exploited to make sense of this complex data more efficiently. The paper, "Interactive heirarchical dimension ordering, spacing and filtering for exploration of high dimensional datasets," laid the groundwork for subsequent research and influenced the design of other tools and techniques, the award committee noted.

"Citations to the original paper have increased over time, showing evidence of lasting value, and the ideas introduced in the work are still relevant today," the award committee wrote. "The paper shows us how we can solve a problem through interactive visualization design and presents convincing options for future analysts and designers. These ideas underpin subsequent research on synthesizing new summary dimensions, contribute to contemporary thinking on explainability, and have influenced the design of many other high dimensional visualization tools and techniques."

Faculty/staff
Elke Rundensteiner

Erin Ottmar

WPI Researcher to Determine How Providing Visual Cues in Math Equations Could Help Students Learn Algebra

Erin Ottmar Receives $667,617 National Science Foundation Grant to Lead Multi-Center Project

▶ LISTEN 00:00

Media Contact
Steven Foskett
Public Relations Manager
Marketing Communications

media@wpi.edu

July 11, 2023

Worcester Polytechnic Institute (WPI) researcher Erin Ottmar has launched a three-year project that will determine how using visual elements in mathematical equations, specifically spacing around numbers and colorful type, could help students learn algebra.

The project, funded with a $667,617 grant from the National Science Foundation, focuses on how visual cues could shift attention to different elements that students perceive when working on algebraic equations. The findings could impact math curricula and classroom teaching.

"When students look at a math equation, they see numbers and symbols in space," said Ottmar, an associate professor in the Department of Social Science and Policy Studies and principal investigator (PI) on the study. "Our idea is that by using a colored font and spacing around groups of numbers in both helpful and unhelpful ways, we can help students recognize and think about correct or incorrect ways to solve an equation."

The research is based on perceptual learning theory and focuses on a critical mathematical concept known as the order of operations, which dictates the sequence of steps to follow when solving a mathematical expression with multiple operations. Students learn to solve operations inside parentheses first, followed by exponents, multiplication, division, addition, and subtraction to reach the correct solution. Failure to follow the order of operations can lead to incorrect solutions. Ottmar said that in her research, students who struggle with math often do so because they ignore the order of operations.

Working with collaborators in Virginia and Indiana, Ottmar will examine the individual and combined effects that using a colored font and spacing around different numbers can have on students' ability to correctly follow the order of operations while solving math problems. The researchers expect to recruit a total of 1,800 students for two studies in Virginia and Georgia. An important issue will be whether color and spacing, when combined with technology interventions, could lead to better, longer-lasting learning.

The project builds on Ottmar's previous research into real-time artificial intelligence tools for teachers to better detect, assess, and predict students' math strategies and knowledge; the role of perceptual learning in mathematics; children's physical gestures and eye movements when learning to solve equations; and using physically active games as an aid to math learning.

Ottmar will work on the project with four co-PIs: Ji-Eun Lee, a research scientist in WPI's Learning Sciences and Technology Program; Caroline Byrd Hornburg, an assistant professor at Virginia Tech; Avery Harrison Closser '19 MS, '22 PhD, a postdoctoral scientist at Purdue University; and Jeffrey Bye, a cognitive scientist and consultant.

"This research benefits from bringing together scholars with expertise in education, psychology, math, and the learning sciences," Ottmar said. "Knowledge from these fields will help us address the core problem, which is that we need to intervene to help younger students develop the core skills needed to succeed at algebra so they do not fall behind and give up on math."

WPI Researcher Looking at How Visual Cues Could Help Students Better Underst...

Erin Ottmar

Associate Professor, Social Science & Policy Studies

Erin Ottmar is an Associate Professor of Psychology and Learning Sciences at WPI. She received her BA in psychology and elementary education from the University of Richmond. After college, she spent several years teaching in Ecuador and Japan. In 2011, she received her PhD in Educational Psychology: Applied Developmental Science from the University of Virginia. After graduate school, spent 3 years as a post-doctoral research scientist at the University of Richmond.

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The Lizard You Actually Want Crawling in the Walls

Flexible robot developed by WPI team sneaks into small spaces for mapping, inspections

▶ LISTEN 00:00

BY: STEVE FOSKETT

PHOTOGRAPHY: MATT BURGOS

WPI researchers have partnered with the City of Worcester to develop a lizard-like soft robot that can creep into walls, ductwork, and pipes to perform inspections and three-dimensional mapping tasks that could be dangerous or impossible for humans.

Funded by a $50,000 National Science Foundation grant, the team— Cagdas Onal, Paul Mathisen, Yunus Telliel, and Berk Calli—collaborated with students and city officials to design the slender and deformable robot, which can get into tight spaces much less invasively than current methods allow.

Left to right: Matthew Urban, Worcester capital projects manager, Ph.D. student Tim Jones, Ph.D. student Gabby Conard, Cagdas Onal, associate professor, robotics engineering.

The team built the prototype robot—an "origami" design made of plastic, 3D-printed, and laser-machined parts, custom circuit boards, a miniature computer, sensors, a few metal parts and motors—and tested it in locations across the city that included City Hall and the Worcester Senior Center. Due to its size and shape, the prototype robot was able to maneuver into the nooks and crannies of the aging infrastructure to unobtrusively navigate inside walls, above drop ceilings, and into ductwork.

Designed to accommodate cameras and sensors that can measure temperature and contaminant levels, the robot can operate with a level of autonomy using artificial intelligence and can map the areas it moves through, collecting important data.

The robot's steering and propulsion systems are separate, and the robot can deform its body—like a lizard—to get into small spaces. Once inside a space, it can travel horizontally and even vertically in narrow spaces. It's able to navigate maze-like structures without getting stuck, and its modular body structure allows it to use multiple

motors to climb over larger steps or gaps, or operate inside pipe networks.

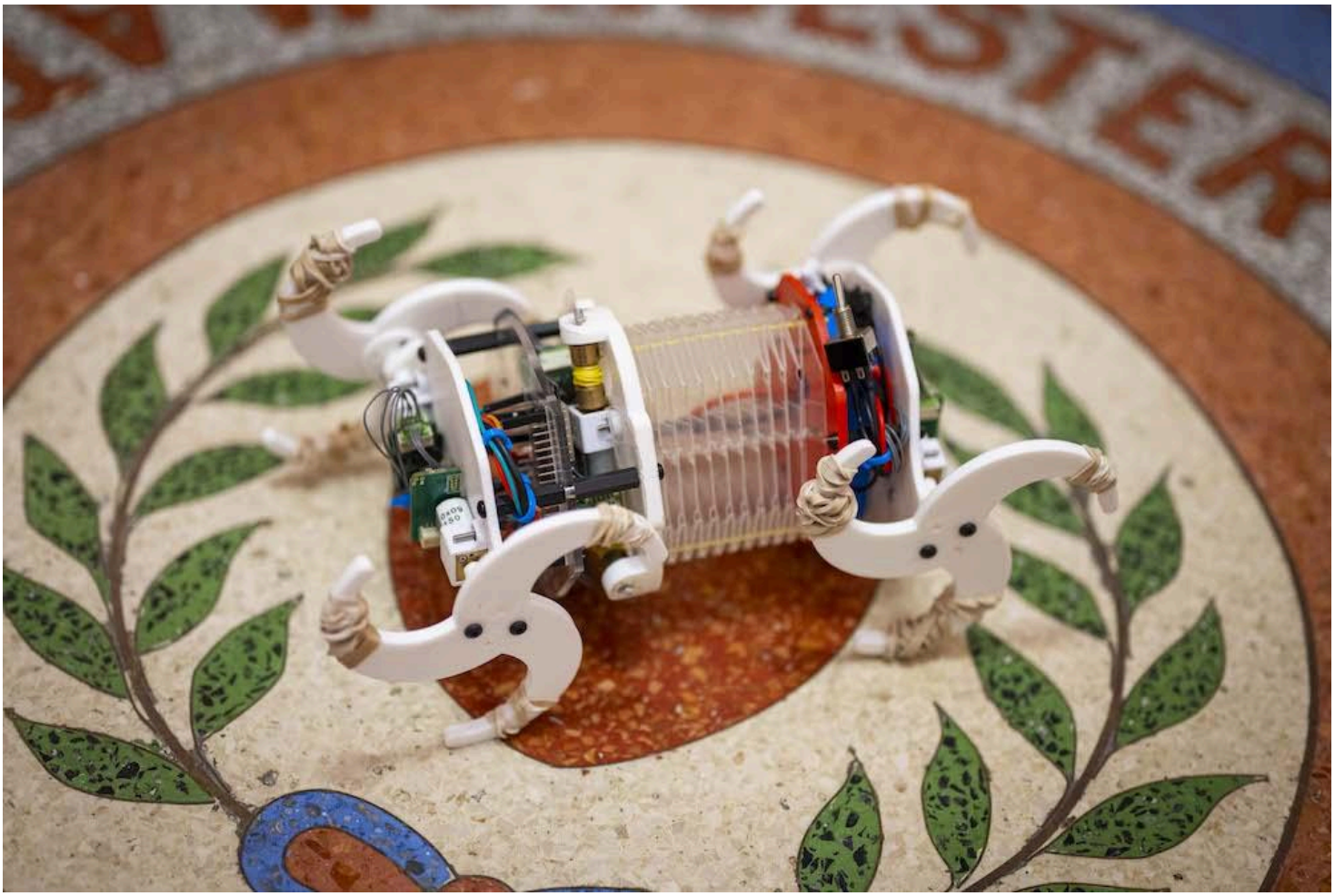
If completed and commercialized, the robot could improve worker safety and make cities more sustainable by making it easier to retrofit buildings for climate adaptation.

“Some of these places the robot can get into are not ideal for worker health,” said Telliel, assistant professor of anthropology. “One of our priorities is to design for the safety of people who would be using this robot.”

As the social scientist on the team, Telliel also said that a significant aspect of this project is its potential to present partnerships with the public and civic sector as a driver of innovation in robotics—what he calls ‘public interest robotics.’

Mathisen, associate professor and director of sustainability, said that for Worcester and a lot of other cities, energy is a major factor when determining the impact of climate change on a population. The robot could be helpful in determining how best to insulate upper areas of buildings, which are susceptible to high heat and energy losses in colder, winter months, and also concentrated heat during summer heatwaves, he said.

Calli, assistant professor of robotics engineering, said the robot’s video and three-dimensional mapping capabilities could bridge the gap between what a municipality knows about a building from blueprints and building permits, and what actually exists. Many older buildings lack detailed plans and have likely had modifications done over the years without much documentation.



Matthew Urban, capital projects manager for the city of Worcester, worked with the WPI team as it developed and tested the robot, providing access to tight spaces in old buildings. He said the robot promises to go beyond the limitations of current scoping technology and could prove to be a critical tool used to carefully update historic buildings.

"City Hall is almost 130 years old," said Urban. "Within the walls, there is plaster, wire mesh, solid masonry, and steel-type construction. Anytime I need to know what's in this wall, I need to cut a hole. Then I need to see if I can get a camera in there, and it needs to look in the right direction, and maybe it's not bright enough. Then I need to go cut another hole."

The process can damage buildings and drain resources from cash-strapped municipalities, said Onal, associate professor of robotics engineering.

"That's exactly what we're trying to avoid," he said.

Onal said the team is developing proposals and continuing its efforts to further refine the design, conduct more testing, and develop a system that supports municipal employees in their efforts to mitigate the impacts of climate change.

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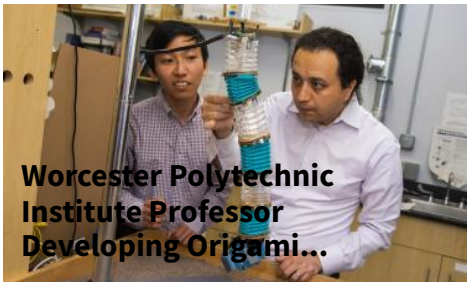

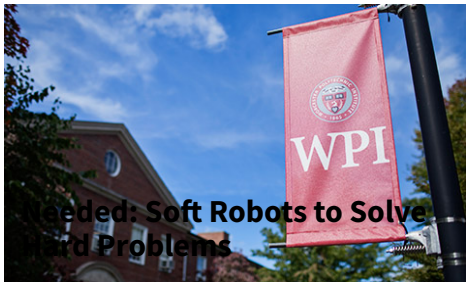

Reeta Rao Appointed as Department Head of Biology & Biotechnology

Department(s): School of Arts & Sciences

October 24, 2023

The Office of the Dean of Arts and Sciences is pleased to announce that Dr. Reeta Rao has been appointed Department Head for Biology and Biotechnology, effective October 1, 2023. Dr. Rao has served as interim Department Head for the past two years, during which time she provided strong leadership and stewardship of the department.

Dr. Rao joined WPI in 2004 as an Assistant Professor of Biology & Biotechnology. Dr. Rao is a leader in the field of molecular genetics and genomics and has affiliate appointments at the Broad Institute of MIT and Harvard University as well as the Institute of Drug Resistance at the UMass Chan Medical School. Her primary research activities are focused on emerging infectious diseases, specifically understanding and managing fungal diseases. Students and research associates in her laboratory are trained to use a variety

of high biochemical, molecular-genetic, and genomic tools to study host-microbe interactions to explore fungal virulence strategies and identify novel therapeutics in a high throughput fashion. Dr. Rao is also deeply engaged in the Global Health and Pre-Health programs at WPI. Committed to the career and professional development of scientists at all levels of training, she has spearheaded several workforce development opportunities aimed at recruiting, retaining and improving the critical skills, knowledge, and resources required for academia as well as industry. Dr. Rao has championed a skills-based MS degree program designed to provide advanced coursework and laboratory techniques applicable to the biotechnology industry. This program was recently recognized among the top two online degree programs in the country. Dr. Rao is a fellow of the American Academy of Microbiology (AAM) and American Association for the Advancement of Science (AAAS) and a recipient of the Waksman Outstanding Teacher Award from the Society of Industrial Microbiology and Biotechnology.

The Dean's office would like to thank the members of the Search Committee who worked on this search while balancing many other responsibilities: Sarah Olson, Professor and Department Head of Mathematical Sciences (Chair); Tanja Dominko, Professor of Biology and Biotechnology; Amity Manning, Associate Professor of Biology and Biotechnology; Anita Mattson, Professor and Department Head of Chemistry & Biochemistry, and Emmanuel Agu, Professor of Computer Science.

Please join us in congratulating Dr. Rao on her appointment.

Sam Walcott Named Director of Bioinformatics & Computational Biology Program

Department(s): School of Arts & Sciences

October 09, 2023

The School of Arts and Sciences is pleased to announce the appointment of Dr. Sam Walcott as Director of the Bioinformatics and Computational Biology (BCB) Program. Dr. Walcott succeeds Dr. Liz Ryder, who served as Director of the BCB program during 2022-2023 as well as from 2013-2017, and now serves as Associate Program Director. The Office of the Dean of Arts and Sciences would like to thank Dr. Ryder for her leadership and service to the BCB Program.

Dr. Walcott joined WPI in 2019 as an Associate Professor and Sinclair Professor of Mathematical Sciences.

Dr. Walcott received his undergraduate degree in Biology from Cornell University in 2001, and PhD in Theoretical and Applied Mechanics, also from Cornell, in 2006. He did a postdoc in Molecular Physiology and Biophysics in the Warshaw Lab at the University of Vermont from 2006-2008, and a second postdoc in Mechanical Engineering in the Sun Lab at Johns Hopkins from 2008-2011. Dr. Walcott was an Assistant Professor in the Department of Mathematics at UC Davis from 2011-2015, and an Associate Professor there until 2019. He was the Associate Program Director of Bioinformatics and Computational Biology in 2022-2023.

Please join us in congratulating Sam on his new role.

Darren Cole

PhD, Computational Media

WPI's Interactive Media and Game Development program allows Darren's passion for art and technology to thrive. He says the faculty in this program "have been very active in considering many of the goals I had coming into the program. I've wanted to learn how to code for many years and tried so many different ways on my own. Once I arrived at WPI, I was coding within a week and have learned this is something I will see myself adding to my creative workflow in the future."

Darren's love of art extends beyond the classroom, taking advantage of the opportunities that come with living in a new place. "I am a practicing artist and I have exhibits in Boston at the Old South Meeting House and at the MassArt x SoWa Gallery," he says. "Moving to Worcester, I feel really focused and ready to do things I have never done before with the progression of my learning. I look forward to this new environment that is built for me to learn with far fewer distractions. It is the most balanced lifestyle I have ever had, and I feel healthy."

Like many other students, his favorite thing about WPI is its community. "Everyone is hungry for knowledge and very focused on completing their goals. I love the level of professionalism and skillsets the students bring to every class. I look forward to growing and meeting collaborators that want to push for a better balance of ethics and social justice within the spaces of emerging technology and humanity," Darren says."Students can dream big and for the rest, WPI will help them figure it out. I have never been at a school that is so proactive in

Hometown
Milwaukee, Wisconsin

Mentor/Advisor

- Jennifer deWinter
- Joshua Rosenstock
- Charles Roberts
- Gillian Smith
- Yunus Telliel

Interests

- Creating and exhibiting art
- Reading
- Exercising

Campus Activities

- Eskate club - Onewheel Ambasador
- International Design Studio (IDeaS) Fellow overseen by Professor Jennifer DeWinter

helping you achieve the goals you have set for yourself. Coming from an art college, WPI's mix of theory and practice is the perfect balance."

After graduation, Darren wants to "teach and make art," he says. "I want to work with underrepresented communities and help them gain knowledge of the hurdles they will face in the future. I also want to continue exhibiting my artwork and use that as a vehicle to help other artists and students. I want them to see the world, grow as individuals, and imagine more opportunities—like going to another state or country, landing the job, or earning that degree. I want to give back while also leaving something behind, so I am really looking to research and one day hope to publish a meaningful contribution in my field."

Students can dream big and for the rest, WPI will help them figure it out. I have never been at a school that is so proactive in helping you achieve the goals you have set for yourself. "

Discover more about WPI students

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FEATURE Winter 2023

Music and Science in Harmony

For Sergio Salvatore ’02, coding is just a form of composing.

AUTHOR

Amy Crawford

POSTED

February 1st 2023

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The piano was **Sergio Salvatore's** first passion. The son of a successful music teacher and singer, he was performing publicly by the age of 4, and he recorded his first album at 11. But while it may have surprised observers when the talented teen went from touring

jazz clubs to majoring in computer science at WPI, Salvatore says the leap has turned out to be far more logical than it first appeared.

"I think that being a musician, especially being a composer or an improviser, is very akin to software engineering," asserts Salvatore, who is now senior director of engineering with the video hosting platform Vimeo. "It's not all that different a process. If you zoom out far enough, you have a certain set of tools, a certain language that you can express yourself in. With music, it's harmony, melody, and rhythm—those are the ingredients, and you manipulate them in order to tell a story. And then when you're designing a piece of software, you have a programming language, you have set of inputs, and you're trying to make it do something. Coding is just a form of composing."

For most of Salvatore's career, he has kept one foot in each of his passions, alternating between coding and composing, between his love of music and his fascination with computer science. It's a sort of dance that, over time, he has learned works best when the two sides are in harmony.

A Musical Destiny

Salvatore was destined for a life in music, from even before he was born. His mother, Carla, trained as a singer, and his father, Luciano, majored in classical piano at Boston University and went on to study and then teach jazz piano at Berklee College of Music. In 1980, he started his own music school in New Jersey. Sergio was born the following year, and music fills his earliest memories.

"It's hard to think of that not being a part of my life," he says. "Music was just in the house all the time. My mom loved the Great American Songbook and Broadway and show tunes. My dad would have students come to the house, and he practiced a lot himself. There was music playing all the time. I guess all kids want to do what their dad's doing, and my dad played piano."

Salvatore soon discovered that he had a natural ability with the keys and a flare for public performance. He also fell in love with jazz, thrilling at the opportunity for improvisation, the way jazz let him follow his musical imagination wherever it led. Luciano soon came to think of the boy as his star pupil and, in 1992, he helped Salvatore secure the opportunity of his young life.

The internet was in its infancy then, and no one had yet dreamed of YouTube, SoundCloud, or any of the other online platforms that performers use to promote themselves today. What ambitious musicians did have, however, was videotape.

"My dad's friend Larry had a camcorder," Salvatore remembers, "and he called a couple of his friends who were session musicians, and they went over to his house and set up in the living room, and we played some tunes that he recorded. And then we copied that tape as many times as we could and mailed it to everyone we knew who maybe had a cousin whose uncle's wife was in the music business. It ultimately ended up in the hands of the director of A&R for a major jazz label. And that's what started the whole train rolling."

Over the next few years, Salvatore would record four albums and go on several tours, performing with the American Jazz Philharmonic, at Carnegie Hall, and in Japan, Italy, and Canada. He played and recorded with more seasoned jazz musicians and won critical acclaim. In 1996, his third album, *Always a Beginning*, landed on *JazzTimes* magazine's list of the year's best albums. All that, and he hadn't yet graduated from high school.

"It was a lot of fun for me," Salvatore says. "I got to play with these really good musicians. I didn't have a sense of the gravity of the situation. Now I realize that just to be talking to these musicians was a real

privilege."

But as he looked toward adulthood, Salvatore faced a dilemma. Would he continue on the path he had chosen at 11, alternating tours and albums as he worked to make a living in an industry that, with the advent of digital technology, was about to be upended? Or would he try something new, exploring a different side of his personality, a different set of talents—and a field that, for better or worse, was poised to change both music and the world?

Two Worlds Converging

As Salvatore considered college, he knew it would have been logical to apply to music conservatories. But that step now felt less necessary—after all, he had already achieved a successful career as a musician, and cultivated a network of fellow musicians and industry connections, a critical component of performing arts education. Meanwhile, he'd long been interested in computer programming, and it occurred to him that studying computer science might be more useful than pursuing a formal credential in music.

"I remember my dad bringing an Apple IIe home in the '80s," he says, recalling the 8-bit green-screen classic, with its 64 kilobytes of RAM. "He would use it to do his taxes, but you could also play games on it. And I got to asking, 'What else can you do?' and "How does that work?'

"This was when there was no internet—you had to go to the library, you got a book or you talked to a friend who knew how to do something on the computer. I got really into that. And then technology was becoming more a part of music, with specialized computers and synthesizers, and as computers evolved there was more that became possible. So those two worlds were converging."

Salvatore set out to find a school where he could study computer science while maintaining a rigorous practice schedule. He wanted to be close to New York City, the center of his musical universe, but not too close—having grown up in New Jersey, he was ready to venture beyond the Tri-State Area. Searching for institutions online—a relatively new approach in the late 1990s—led him to WPI.

"My concern at first was, how am I going to practice?" Salvatore says, "because I'm obviously not going to have a piano in my dorm room."

When he and his family headed to WPI for a visit, school officials connected them with **Doug Weeks**, WPI's longtime coordinator of music. Weeks, who retired in 2021 after spending more than 40 years building

WPI's music program from a single brass band to a full-fledged department, assured Salvatore that there would always be a piano and a practice room available to him. That pledge effectively sealed the deal.

"I left knowing I would be able to do what I wanted with both music and computer science," Salvatore says. "So Doug Weeks is one of the significant reasons why I ended up at WPI."

In fact, the entire music department was excited to have Salvatore at WPI. **Professor Rich Falco**, director of jazz studies, remembered seeing him perform before an audience of 3,000 jazz teachers at the International Association for Jazz Education several years prior, when Salvatore was just 12.

"Sergio's connection to the piano was immediately evident," Falco says. "It was clear that he was not simply executing a piece, but was channeling directly to the keyboard what he heard internally, in the same way experienced professional jazz musicians play. I was very pleased when he chose to come to WPI, because I thought WPI would offer him an opportunity to explore deeply his obvious creativity."

> "Sergio's connection to the piano was immediately evident. It was clear that he was not simply executing a piece, but was channeling directly to the keyboard what he heard internally, in the same way experienced professional jazz musicians play. "
>
> Professor Rich Falco

Salvatore arrived on campus in 1999, at a time when seismic changes were taking place in the tech industry. Already accustomed to an intense schedule of practicing, touring, and recording on top of his high school classes, he realized if he worked even harder and compressed his education into three years, he could get out into the world sooner, positioning himself to seize new opportunities.

"I saw what was going on in the business world," Salvatore says. "Friends were out with jobs, making money and doing stuff. I wanted to get out there, too."

Naveen Selvadurai '02, MS '03, a freshman year neighbor who would become a lifelong friend, remembers sharing that eagerness. It was a heady time to be studying computer science, and the friends

bonded over their love of Apple products and their dreams of getting in on the digital revolution.

"It was all about telecom companies and software companies and dot-coms changing the world," says Selvadurai, who also compressed his bachelor's degree into three years and is now an entrepreneur and venture capitalist based in Southern California. "The dot-coms proved that anybody could make something—you know, this whole trope of two guys in a garage. I think we had that mindset as well. We both wanted to do things our own way, build things for ourselves."

Making Cell Phones Sing

Even as he was working to graduate as soon as possible, a part-time job the summer before his sophomore year offered Salvatore a toehold in tech—one that, at least tangentially, called upon his skills as a musician. Through music industry connections, he met the founders of a New York-based start-up called RunTones, which created ringtones and wallpapers for mobile phones. They offered him a gig, and soon he was figuring out how to make those early cell phones sing.

"I'm under no illusions that a ringtone is a highly artistic sort of thing," he says with a laugh, "but we tried to apply that kind of thinking as much as possible to get the best quality ringtones. And it was an interesting challenge, because the early phones were so primitive. They kept getting a little bit better and a little bit better, but it felt like the Wild West, because there wasn't any sort of commonality among the different models. A lot of the time we were just exploiting bugs to make it work the way we wanted to."

In 2002, the year Salvatore graduated, RunTones was acquired by Sony Music Entertainment, which made it the foundation of the division's mobile products group. Salvatore would spend 10 years with Sony, first managing the development of mobile products, then branching out into the nascent technology of direct-to-consumer music sales. All the while, he was watching digital technology transform the business he had grown up in.

"The music industry has generally been at the forefront of technological change," Salvatore says. "If you look at media evolution, it was music that embraced digital technology first, and then it sort of filtered on down to movies and publishing. But that cuts both ways, because if music gets the benefit of being first, it's also often the industry that ends up making all the mistakes at the beginning."

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>
> Sergio Salvatore

Over the early 2000s, it became at once easier for musical talents to find an audience—no more mailing videotapes to friends in the era of YouTube and Vimeo—but also more difficult to make a living the traditional way, by recording albums with the support of a record label.

"In the 1990s, when I was doing records for major labels, the problem was getting shelf space," Salvatore explains. "People still went to stores to buy CDs, and if you had a 2,000-square-foot store, how many square feet are dedicated to the jazz aisle?" And within the jazz aisle, Salvatore notes, the shelves were dominated by best-selling artists, all of which resulted in a high barrier for a new musical act to reach the wider public. The internet eliminated that physical limitation, making it possible—at least in theory—for any audience to find any media. But soon it became difficult to break out amid a sea of artists and content creators.

"So I don't have to compete with Miles Davis anymore," Salvatore says. "But now I'm competing for attention with cat videos, or a parakeet pecking away at a song on YouTube. What I didn't realize then was if you open those floodgates, then you're opening them to everyone."

Finding the Fun Again

As the music industry was in upheaval, Salvatore's media technology career was soaring, and for a time it became his primary focus. From Sony, he moved on to lead engineering teams at Barnes & Noble and then Steinway & Sons before joining Vimeo in 2017. Eventually, he realized that entire years had gone by in which he hadn't given a single performance.

"And soon I realized that I was unhappy, because I was not exercising that part of my brain or that part of my life," Salvatore says. "So I said, 'Okay, enough with this, I'm going to just produce my own concert. I'll get

my friends, whoever I can find to play. I'll produce it myself, try to get some people to show up—and for no other reason than I want to, it's going to be fun for me.'"

In the years since, Salvatore has recorded two more albums, this time promoting them on digital platforms like Spotify. He also reconnected with WPI, joining the School of Arts & Sciences Advisory Board in 2012 (he is currently co-chair). That's provided opportunities to meet a diverse array of WPI alumni, as well as to support the music department and the university in general.

An especially fulfilling experience came in 2018, when the threads of Salvatore's life as a musician, technologist, and WPI alum came together in a performance at the Rubin Campus Center Odeum for the launch of WPI's neuroscience program. The appearance was part of a symposium called "Music and the Brain," which explored the potential for music as a treatment for neurological disorders. It was also an opportunity for WPI researchers to consider the ways in which creativity can work across disciplines. That's something that makes perfect sense to Salvatore, whose original jazz piece, composed for the occasion, was titled "That Goes Without Saying."

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Heart Rhythms and Algorithms: AI and Health

Critical Conversation Series Explores Potential, Risks of AI in Healthcare

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BY: STEVE FOSKETT

Startlingly competent generative artificial intelligence may have burst into the public consciousness in the past year or so, but the technology's underpinnings have been in place for decades, and AI has become an integral part of our lives—in our homes and cars, on our phones, and in our doctors' offices.

The intersection of healthcare and AI served as the backdrop for the Critical Conversation series at WPI's fall Arts & Sciences Week. While the discussion at the Rubin Campus Center was driven by practical applications in hospital settings and ethical implications for patient safety and equitable care, the wider conversation about AI will continue at WPI, said President Grace Wang. WPI will explore new research questions, degree programs, academic technologies, and other opportunities related to AI, she said.

"Taking no action is not going to be an option for us as a STEM institution," Wang said. "In fact, our expertise in the field makes us a natural fit to lead on educating the next generation of AI experts."

Jean King, WPI Peterson Family Dean in the School of Arts and Sciences, served as emcee for the event, which she said was intended to foster open dialogue and discussion about pressing issues of our time. The panel included the following:

Elke Rundensteiner, William B. Smith Professor of Computer Science

Emmanuel Agu, Harold L. Jurist '61 and Heather E. Jurist Dean's Professor

Carolina Ruiz, Harold L. Jurist '61 and Heather E. Jurist Dean's Professor

Edwin Boudreaux, professor of emergency medicine and co-director of the Center for Accelerating Practices to End Suicide through Technology Translation at UMass Chan Medical School

Dr. David McManus, the *Richard M. Haidack Professor of Medicine* and chair and professor of medicine at UMass Chan Medical School

Below are thoughts from each panelist:

Rundendsteiner, on ensuring people know how AI is being used for decisions that impact their lives:

I'm interested in AI and understandability. When we make a decision using AI, can the person the decision is being made for understand why that decision is being made, and for what reasons? Why is a bank telling someone, for example, that a loan is being denied? The person might not know all the data the bank is reviewing and why. Or, why is a doctor recommending a certain medical procedure? How does this person know what AI system led to that decision?

Agu, on how AI will expand access to quality care:

The potential to democratize healthcare through AI is there. There are many people out there who could never meet a cardiac surgeon because they live in a part of the world where they don't have access to those types of health professionals. But with AI, we're able to train models that learn from these experts and push that knowledge out to the edges—push it out to people who have never had access. Essentially, a person from a remote part of America, or in a developing country, can access the best expertise in the world because the models we train are based on the labels generated from experts who are the most knowledgeable in the world.

Ruiz, on using AI to help treat sleep disorders:

Sleep medicine is an amazing field to be in, because sleep is a thing we all have a connection with, an experience with. In a traditional sleep study, someone will come and stay overnight, and we collect lots and lots of signals—their brain activity, breathing, heart activity, temperature, and muscle movement. We are producing data and using AI to create deep learning models that are able to predict and help diagnose sleep disorders, which can be important in diagnosing other aspects of people's health.

Boudreaux, on the role AI can play in suicide prevention:

Think about your own lives–if you're like other groups of people, the majority of you knew someone who has died by suicide. The tragedy is that among all those people, the majority were seen in a healthcare setting within a year before they died. Thirty-five percent saw a healthcare provider a month before they died, and the vast majority were not identified as at-risk. We have opportunities to intervene, but we don't act because clinicians are bad at identifying risk. Machine learning models are good at identifying risk, because that's what they're designed to do: predict who may be most vulnerable and most at-risk for suicide. This is what we're working on in our center: building better models to help us identify when an individual is at-risk, monitor that risk over time, and cue clinicians to act at the right time with the right intervention to prevent suicide.

McManus, on AI's potential to improve healthcare outcomes:

When I'm in clinic, a patient will see me for, say, high blood pressure, or they'd had a heart attack. I'll typically I look at their electronic health record—I'll look at a patient's last few blood pressures, their history, their medicines list. I'm doing homework before I see the patient, which I think is standard practice and best practice. The truth is, though, there are billions of data points within that electronic health record on that individual. And to be frank, in my 15 minutes of homework I may miss a laboratory test that was abnormal, or a record from an outside hospital, if the patient doesn't tell me about that. It shows where AI would be a wonderful co-pilot for well-meaning physicians to take care of their patients.

Watch video of the forum here.

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AI Helps Neuroscientists Understand Depression Better

Researchers used large language models to aid in their study of depression

Sascha Brodsky, Contributor

October 12, 2023

4 Min Read

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At a Glance

> Researchers developed 'explainable AI' to understand AI decisions and identified distinct brain patterns for depression.

AI is helping neuroscientists decipher the enigmas of depression, marking the expanding use of large language models to delve into the intricacies of the brain.

Researchers have built algorithms for explainable AI, which enable humans to grasp the decision-making mechanics of AI systems. The approach helped the team discern the distinct brain patterns that set apart a “depressed" brain from a "recovered" one, according to a recent paper. Studying the brain can also provide insights for AI research.

“Much of the work on AI right now is actually inspired by brain research and how brains work,” Erin Solovey, an associate professor in the Department of Computer Science at Worcester Polytechnic Institute, who was not connected to the recent research, said in an interview.

“At the same time, many of the computational methods being developed in the fields of AI and machine learning are valuable for finding patterns in large, complex datasets. These algorithms

Going deep into the brain

As part of the AI-assisted study, researchers from Emory University, Georgia Institute of Technology, and the Icahn School of Medicine looked at the brain activity of patients with deep brain stimulation (DBS), a treatment involving brain-stimulating electrodes. They found a unique brain activity pattern in patients recovering from severe depression. This identifiable pattern, called a biomarker, indicates disease recovery.

Related: AI tool predicts Parkinson's from breathing patterns

DBS is like a brain pacemaker, using electrodes to send electrical pulses. It is common for Parkinson's but still new for depression. The study gathered data from these electrodes to see how patients respond. The data helps doctors adjust and improve the treatment for each person.

The researchers also used AI to detect shifts in brain activity that corresponded with patients' recovery. The team also found that as patients' depression lessens, their facial expressions change. Their AI tools spotted facial patterns showing a shift from illness to recovery, which were more accurate than current clinical scales.

"This approach enabled us to track the brain's recovery in a way that was interpretable by the clinical team, making a major advance in the potential for these methods to pioneer new therapies in psychiatry," wrote Sankar Alagapan, a Georgia Tech research scientist and lead author of the study.

AI for brain research

The study on depression is part of a growing trend of research initiatives utilizing AI to delve into the brain's mechanics. One recent success in theoretical neuroscience compares brain activation and the GPT model.

who studies computational neuroscience and who was not involved in the recent study, in an interview.

“For example, both the brain and the GPT are predicting what word will come next when receiving input,” he added. “We are not able to understand such principles of neural processing of language without the help of the AI model. Another success in application is reconstructing high-resolution images from brain activity. ‘Mind-reading’ in high resolution is considered a very difficult task, but with AI help, we can reconstruct pretty well what someone has seen by recording their brain activity through fMRI.”

The brain is like a 'black box' because we know so little about it, according to Li.

Many AI systems are like 'black boxes' because we don't fully understand how they operate. He said researchers can use AI as a black box to mimic the brain.

“Without the AI system, scientists are left with very few tools to simulate high-level brain areas,” he added. “That is because we do not have many ways to manipulate the human brain, but we can easily manipulate the AI system.”

For instance, Li said researchers cannot ethically damage a human brain to see its effects, but they can remove artificial neurons in AI and observe its behavior.

“We can then study how different goals of training and training data will shape the artificial neural network, and we can then compare those systems with the human brain and look for similarities and differences,” he added.

“In addition, we do have full control of the goal of learning and the learning data that the system has accessed. We can then study how different goals of training and training data will shape the artificial neural network, and we can then compare those systems with the human brain and look for similarities and differences.”

Future advances could benefit both AI and neuroscience research. Algorithms can spot irregularities, find patterns, and handle noisy data, Solovey said.

addition, the large datasets are leading to AI models that can classify particular cognitive processes in real-time. This could lead to AI tools that enable us to monitor health and well-being and to enhance human performance."

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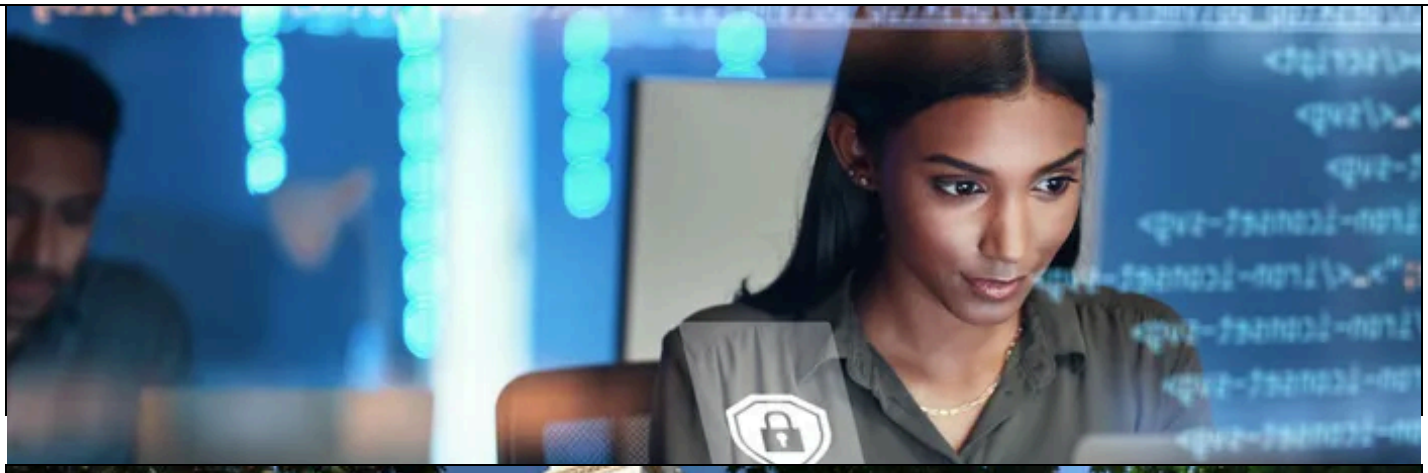

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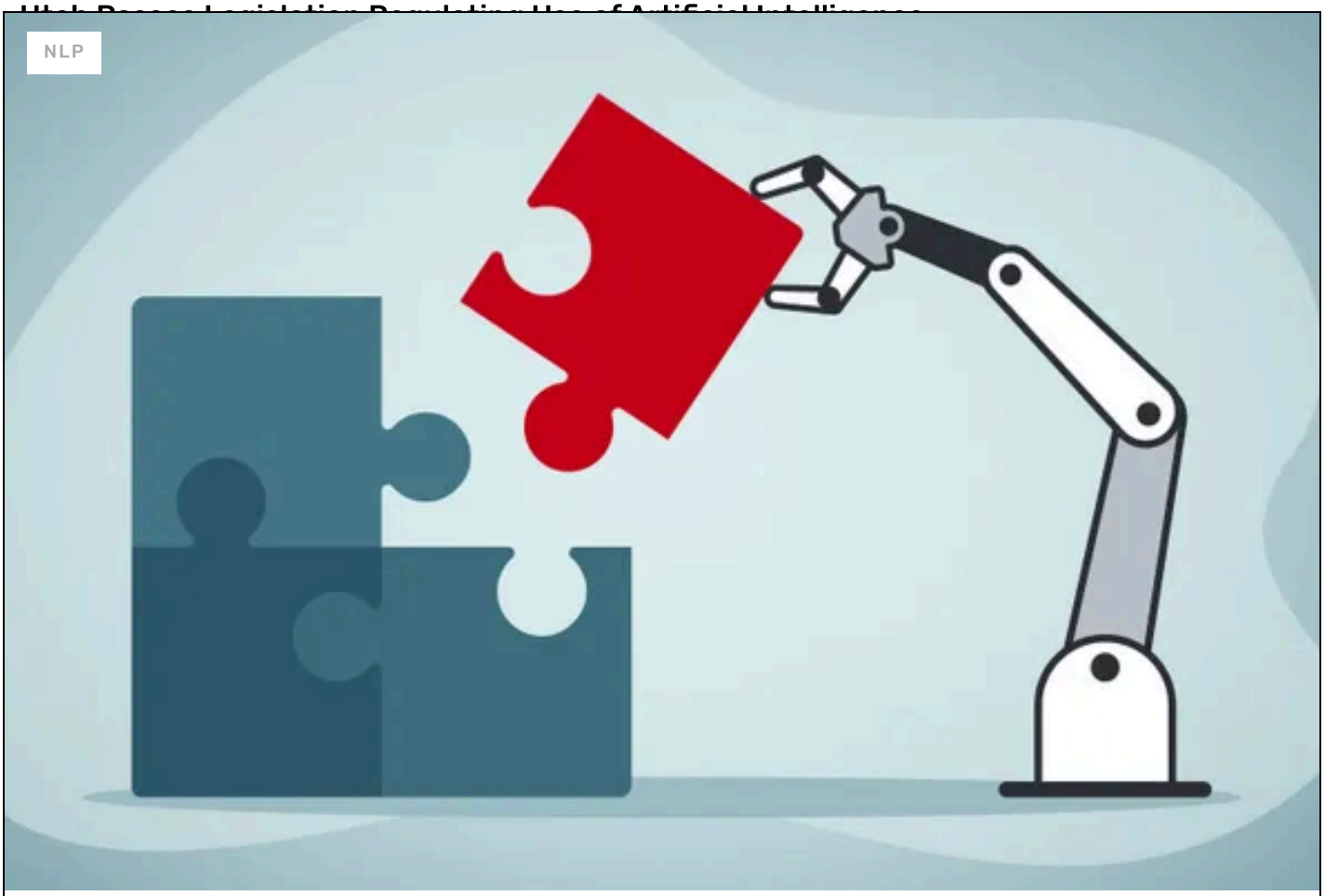

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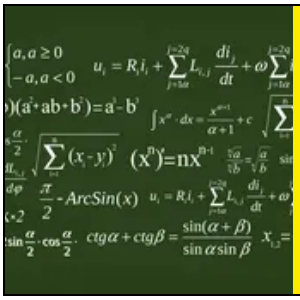

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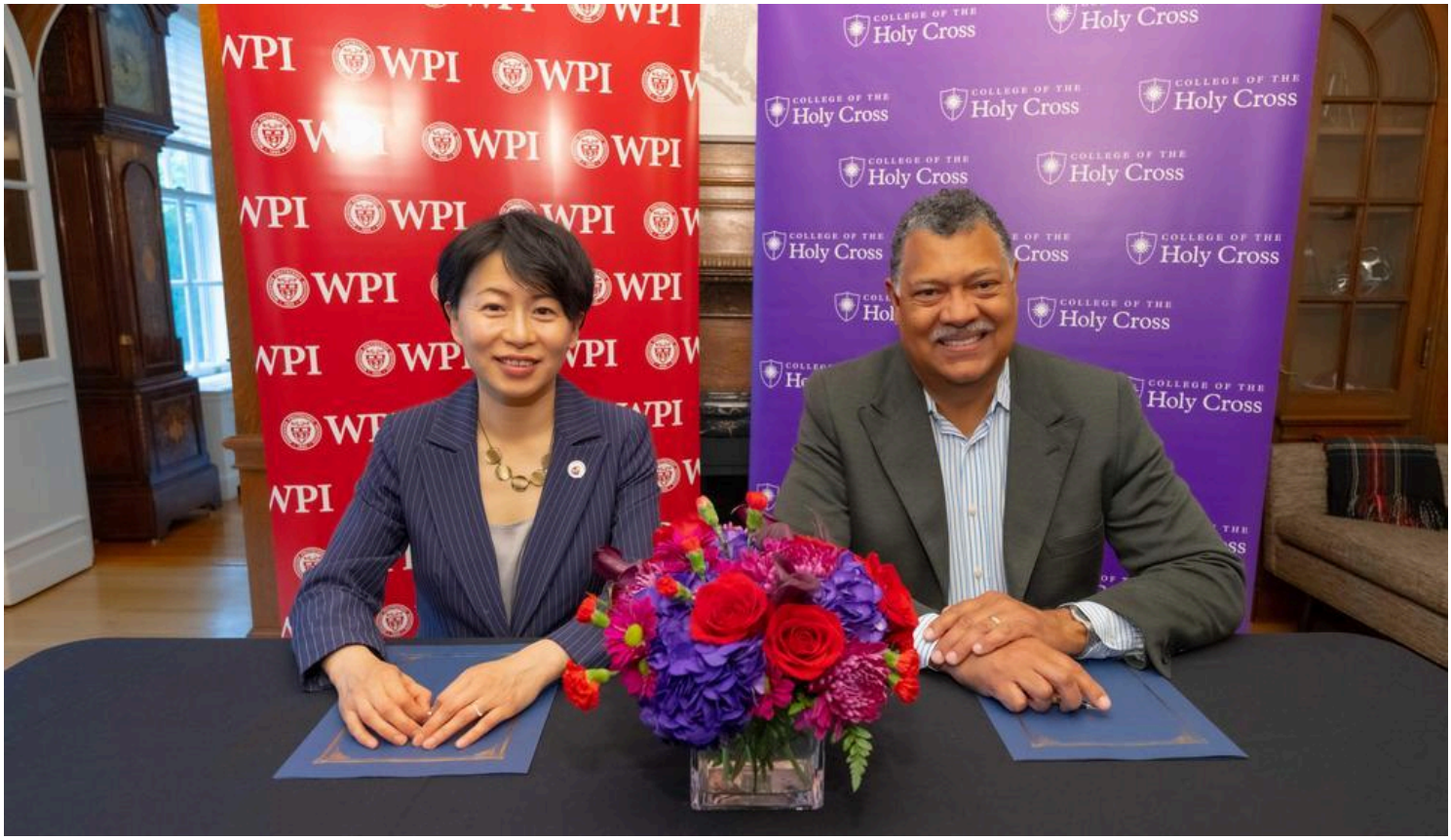

Worcester Polytechnic Institute and the College of the Holy Cross To Develop Innovative Dual Degree Programs

The initiative combines the distinctive strengths of both institutions.

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PHOTOGRAPHY: MATTHEW BURGOS

Two of Worcester's oldest and largest institutions of higher education have announced a new partnership to strengthen collaborations and provide new pathways for students. Worcester Polytechnic Institute (WPI) President Grace Wang and College of the Holy Cross President Vincent D. Rougeau signed a memorandum of understanding (MOU) to collaborate on combined Bachelor's/Master's programs.

These programs will provide opportunities for Holy Cross students to complete their Bachelor of Arts (BA) degree at Holy Cross and their Master of Science (MS) or Master of Engineering (MEng) degree at WPI in an accelerated 4+1 model.

"For many years, WPI and Holy Cross have worked cooperatively on common goals and to engage in topics of mutual interest – and to drive positive changes in the best interest of higher education in Central Massachusetts. Now we are expanding our partnership, reflecting the innovative spirit of our respective institutions to foster an even closer network of collaboration," said Wang. "This partnership will provide pathways for Holy Cross students to pursue graduate studies in a distinctive STEM institution while enriching WPI with exceptional graduate candidates."

"We are delighted to collaborate with WPI on these innovative educational programs," said Rougeau. "This partnership helps us expand our curriculum by connecting our model of outstanding liberal arts education with graduate training at one of the nation's great technological universities. At the same time, we are able to work together to deepen our shared commitment to Worcester as a great place to live and learn."

Holy Cross juniors majoring in mathematics and computer science or physics will be eligible to start the path toward completing the 4+1 program by taking WPI courses.

Initial MS and MEng degree programs at WPI that are participating in this partnership are mechanical engineering, and electrical and computer engineering, with more offerings in computer science, mathematics, physics, neuroscience, business, and sustainability to be available in the near future.

Faculty and administrators from both Holy Cross and WPI will be working together to build out the program offerings over the next several months.

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