IDSC enabling DISCOVERY

UNIVERSITY OF MIAMI

FROST INSTITUTE for DATA SCIENCE & COMPUTING

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Data science holds the key to tackling society's greatest challenges. From the COVID-19 pandemic to smart cities, social justice, or the global environment, a leading-edge computational approach can extract hidden knowledge and generate fresh insights from large and complex datasets across many different sectors.

Leveraging the University of Miami's state-of-the-art technology platforms, including an AI-ready supercomputer and 5G+ edge computing environment, the Institute for Data Science and Computing (IDSC) supports basic and applied research initiatives University-wide, and shares ideas, insights, and resources.

As a member of the University's Frost Institutes of Science and Engineering, IDSC is also launching new programs in data science, and building close ties with academic institutions worldwide to develop educational, research, and community partnerships. IDSC's focus on collaboration also extends to industry, government, and nonprofit partners who recognize the University's ability to provide valuable support.

Explore how the U's powerful resources in data science and computing can help you achieve your research, training, and business goals.

Nick Tsinoremas | FOUNDING DIRECTOR
Ben Kirtman | DEPUTY DIRECTOR

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- AI + Machine Learning
- Data Ethics + Society
- Digital Health + Life Sciences Informatics
- Earth Systems Science
- Human Centered Design + Computing
- Smart Cities + Smart Environments

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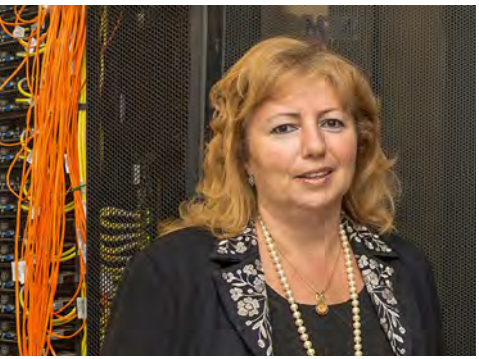
AI + Machine Learning

Navigating investigations in oceans of data and making discoveries is possible only with the use of efficient algorithms. As data grows in volume, velocity, variety, and veracity, so does the demand for efficiency in data science applications. Artificial Intelligence(AI) and Machine Learning (ML), will streamline algorithms based on algorithmic and methodological developments from the field of AI. The computational methods of AI aim to mimic human intelligence but also to exceed human capabilities, assisting humans in decision making and in solving complex problems.

The numerous branches of AI encompass ML, natural language understanding (spoken and written), computer vision, data mining, human-computer interfaces, data visualization, and, more recently, deep learning. In all these areas, data plays a crucial role as algorithmic innovations are developed from within while taking inspiration from mathematics, statistics, and physics. The applications of these major branches of AI are broad, reaching far beyond the traditional realm of science and engineering, and ushering in crucial advances in medicine, the social sciences, business, and even the arts and the humanities.

Through IDSC, the University is developing an AI testbed that gives scientists access to state-of-the-art AI/ML tools and a dedicated high-performance computing infrastructure incorporating human experts in the loop for developing, evaluating, and addressing the most challenging AI/ML application problems.



Yelena Yesha, PhD
DIRECTOR

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ARGO AI ON YOUTUBE | HOW SELF-DRIVING CARS "SEE"

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Lid Vizion co-Founder + Business Lead Shawn Wilborne, Esq., (UM Law '20) MSSB, displays the prototype app with College of Engineering Prof. Amin Sarafraz, PhD (UM '12) from the IDSC Systems and Data Engineering group.

"Identification of Mixed Plastics and Valuable Electronics at the Source"

A REMADE Institute award to IDSC + Lid Vizion is funding work on one of 12 deemed "best" projects dedicated to transformational manufacturing and recycling.

The REMADE Institute, a public/private partnership established by the U.S. Department of Energy (DOE), is the first institute dedicated to accelerating the nation's transition to a Circular Economy. According to the DOE, manufacturing accounts for 25% of U.S. energy consumption, at a cost of approximately $150 billion. Based on data from the EPA, industry is the third-largest contributor to greenhouse gas emissions in the nation at 22%. REMADE and its partners are determined to reduce those numbers significantly, while creating new, clean-economy jobs.

Project collaborator Lid Vizion provides advanced technology to the waste and recycling sector to tackle contamination. Lid Vizion's mission is to clear up confusion and clean up human consumption. They help identify value in trash and prevent hazardous materials from polluting our communities.

This University of Miami collaborative project "Identification of Mixed Plastics and Valuable Electronics at the Source" is developing an Artificial Intelligence model that recognizes materials at the residential level, and can distinguish between confusing plastics based on what type of mixed plastic is accepted curbside versus drop-off and proper e-waste at a per-receptacle-level based on recycling regulations. The anticipated results of this project will move the U.S. closer to the nation's energy conservation and emissions reduction targets by helping residents dispose of materials according to local regulation and material lists, and by preventing mixed plastics and e-waste from going to waste.

Principle Investigators
Amin Sarafraz, Shawn Wilborne, Lamar Giggetts

"We are developing an AI model that can recognize different types of recyclable and non-recyclable materials *at the source.*"

-SHAWN WILBORNE, ESQ., MSSB
Co-Founder and Business Lead
LID VIZION

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Data Ethics + Society

Who owns an individual's data? How do you balance the right to privacy with public safety? Who should review the underlying assumptions that shape artificial intelligence (AI) and machine-learning algorithms? IDSC is committed to identifying, addressing, and resolving these ethical, legal, and social challenges in collaboration with the University of Miami's Ethics Programs and Institute for Bioethics + Health Policy.

IDSC recognizes that data ethics and social issues underlie all aspects of information technology, including computational science, software engineering, AI, and deep learning.

That opens to the door to a wide range of research projects with immediate relevance to current social issues, and to questions with long-term implications.

IDSC's collaborations include across-the-curriculum contributions to teaching and learning, including innovations in incorporating data ethics into UM's Responsible Conduct of Research training. These relationships have stimulated research on topics ranging from appropriate uses and users of intelligent machines to privacy challenges raised by data collection and analysis, surveillance, and secondary use.

Ken Goodman, PhD FACMI FACE
DIRECTOR

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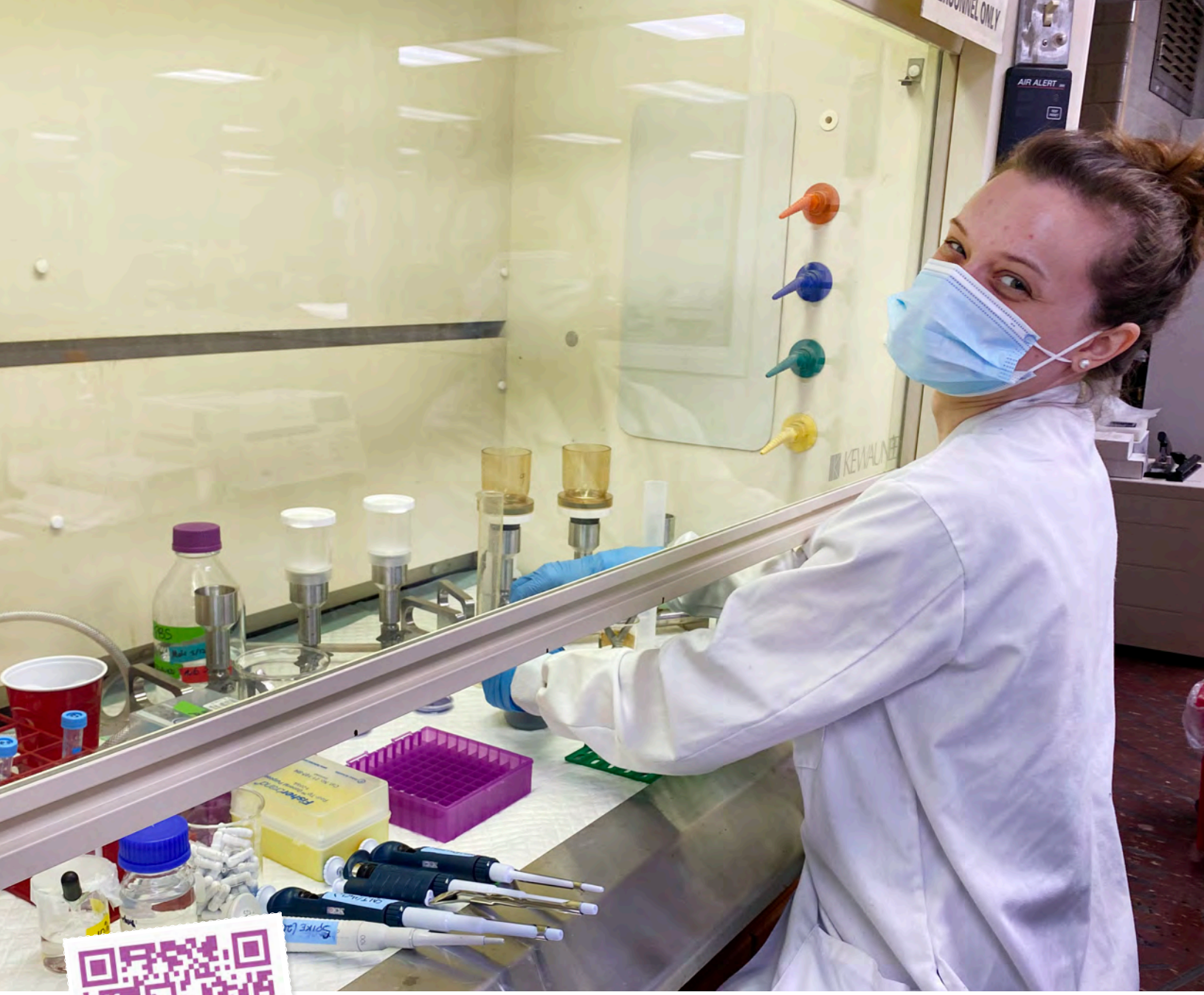

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Researcher Kristina Babler, MPS (UM '21), tests wastewater samples as part of the collaborative UM / Weill Cornell Medicine RADx-rad SARS-CoV-2 Wastewater-Based Surveillance project. Project Website: covidsfrad.org.

Early Covid-19 Detection Through Wastewater Surveillance

A University of Miami-led team recently received a major Federal grant to study how wastewater can be used to help predict Coronavirus outbreaks.

Cutting-edge research to detect SARS-CoV-2 (the virus that causes COVID-19) in wastewater may provide up to a week's notice ahead of positive test results to warn students and faculty that they should get tested and self-isolate before the illness spreads.

A team of 40 UM faculty, staff, and students received a major two-year grant of $5 million from the National Institutes of Health (NIH). The team will also join an NIH consortium organized to collect and standardize data from other institutions across the U.S. that are also testing wastewater for the virus. These researchers will utilize next-generation sequencing technology to characterize SARS-CoV-2 genetic variations, look for novel viruses, and link this data to national and global efforts to track emerging pathogens. Ultimately, the team hopes to create a primer they can share with leaders across the nation about the best ways to identify the virus in wastewater and how it can be used to quickly warn individuals of potential infection. They also hope to offer strategies that communities can use to reduce imminent transmissions when they detect a spike in wastewater.

Project Title
South Florida Miami RADx-RAD SARS-CoV-2 Wastewater-Based Surveillance Infrastructure

Principle Investigators
Helena Solo-Gabriele, Chris Mason, Stephan Schürer

"We are learning this is a powerful tool to understand which illnesses a community has, and how humans are contributing—not only for COVID-19 but for public health in general—because we can use it to monitor many different pathogenic organisms."

-HELENA SOLO-GABRIELE, CO-P.I.
UM Associate Dean of Research, College of Engineering

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Digital Health + Life Sciences Informatics

Digital health care has entered an era of major data transformation spurred by the use of advanced analytics and related technologies. Data-driven translational research, population health management, and precision medicine have served as the catalyst. IDSC Digital Health and Life Sciences Informatics encompasses Digital Drug Discovery, Population Health Informatics, and Social and Behavioral Data Science.

The University of Miami, as a learning health care system—one in which knowledge-generation processes are embedded in daily practice to produce continual improvement in care—affords availability to millions of UHealth patient records.

With this access to massive amounts of structured and unstructured patient data across a wide range of data sources, the application of data science can aid in diagnosing patient conditions, developing new therapeutics, matching treatment with best outcomes, and predicting risk levels for disease (identifying comparable physical symptoms in patients who are the same age, gender, and ethnicity, and who display similar responses to a specific medication).

IDSC's technology platforms allows physicians and researchers to analyze vast data sets across different systems, informing healthcare decisions, and transforming basic and translational biomedical research.

Stephan Schürer, PhD
DIRECTOR, DIGITAL DRUG DISCOVERY

Azizi Seixas, PhD
DIRECTOR, POPULATION HEALTH INFORMATICS

Daniel Messinger, PhD
DIRECTOR, SOCIAL AND BEHAVIORAL DATA SCIENCE

Patient: *Caitlin Ross*
Diagnosis: *Heart Condition*
Dr. Antonio Barquet
Cardiology

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Gaining access to high-quality early learning programs is a national issue. There are a number of barriers, including difficulties in obtaining good information. That points to the importance of this initiative as a pilot for future programs.

Partnership Provides Early Education Tools for Haitian-American Families

A game-changing, mobile-friendly application will help parents and families find access to early-learning websites, and will serve as a replicable model for other communities.

For two decades, the Sant La Haitian Neighborhood Center has been a vital resource for local families. Now, they are making it easier for parents to access early childhood education resources through a new partnership with the University of Miami and a host of community partners. An IDSC data science team is creating a mobile-first, web-based application that will assist parents in finding quality early learning sites and related programs.

This mapping tool requires extensive research to determine eligibility requirements, service areas, registration procedures, and other information from each organization. The data must then be integrated so it can be accessed easily by a web application. Another challenge is curating the data and determining how to best present the information to parents.

This multi-agency partnership will help build a data system that provides a big picture of what's happening in early learning, while creating a simple, useful tool for parents. Upon completion, the app will be rolled out first to 'trusted messengers' in the community who will provide technical support to parents to navigate and use the application.

Partners

The Children's Trust, the Early Learning Coalition, Head Start/Early Head Start, Miami-Dade Co. Public Schools, Miami-Dade IDEAS Consortium for Children, UM's U-Link program, the Miami Foundation, the Sant La Haitian Neighborhood Center, and Together for Children's Northeast Corridor Early Learning

"While we are using data to improve services and outcomes for the community, this is *also* a research initiative whose findings may inform the work of service providers and policy-minded leaders."

-REBECCA J. BULOTSKY-SHEARER, PHD
UM Associate Professor, Department of Psychology

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Earth Systems Science

Vast quantities of data and powerful analytic tools are needed to analyze complex weather patterns, track ocean currents, or predict seismic events. IDSC's computational power and analytic platforms can help researchers develop sophisticated models based on highly diverse datasets with abundant information, as well as those with sparse data and high uncertainty.

Machine learning (ML) techniques can detect rare but extremely dangerous events such as tsunamis, submarine earthquakes, and volcanoes, and aid in life-saving early warning systems. By pairing ML with Bayesian statistics, researchers have access to multiple prediction tools for more reliable forecasts, and a detailed understanding of the ever-present uncertainties.

IDCS Earth Systems Science researchers are using these resources to address atmospheric, oceanic, and earth science problems—particularly in areas where direct observations are difficult, such as the deep ocean, polar ice caps, and upper atmospheric wind currents. One example is the North American Multi-Model Ensemble (NMME) for climate prediction, developed at the University of Miami and adopted by the National Oceanic and Atmospheric Administration (NOAA), which provides guidance to the Federal government.

Benjamin Kirtman, PhD
DIRECTOR

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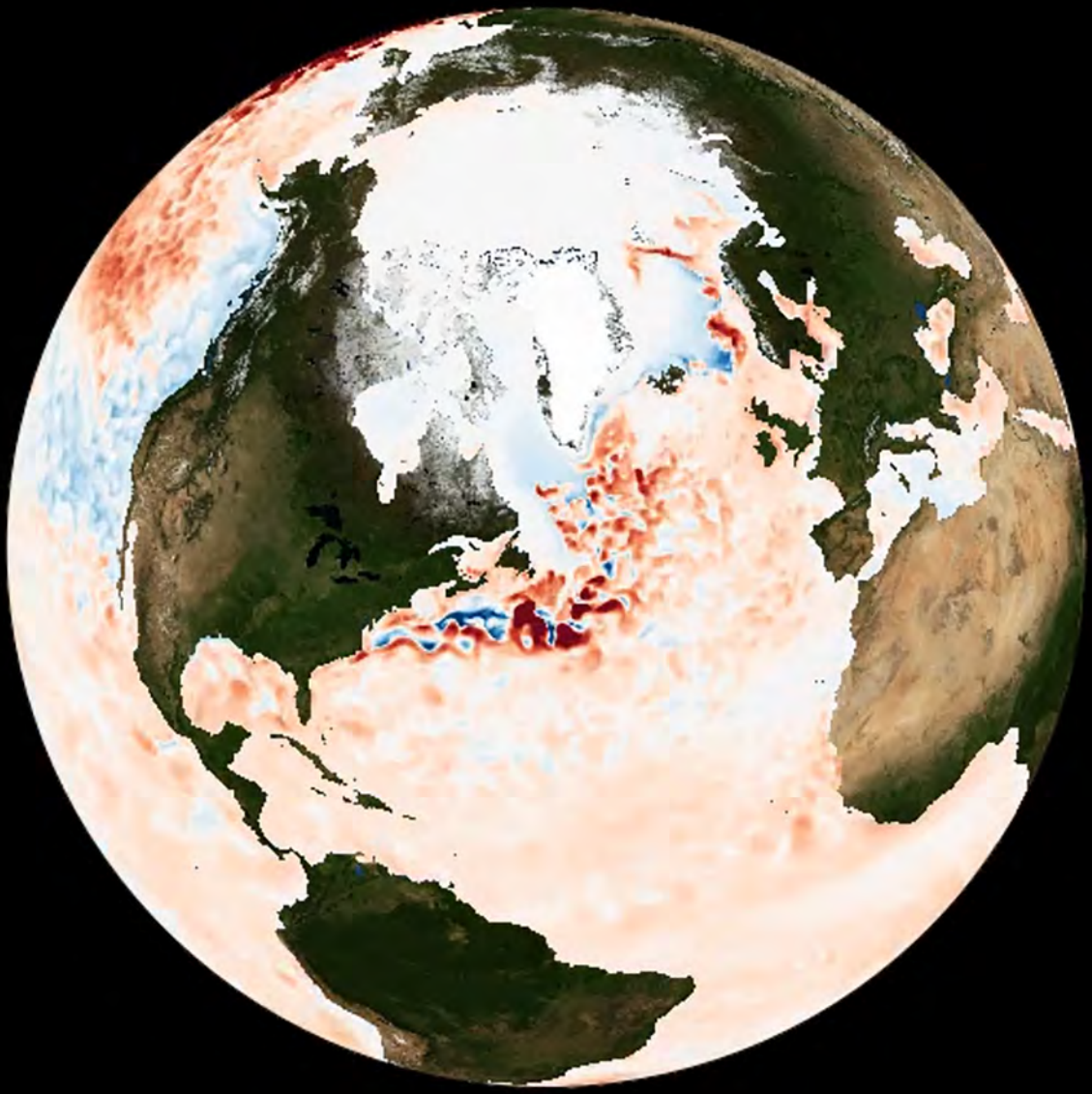
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Human Centered Design + Computing

Visualization and Creative Technologies

It can be challenging to convey the meaning of complex models and data sets clearly and accurately to journalists and the public. Visualization is an effective strategy for presenting scientific findings in an understandable manner, as well as for identifying significant patterns hidden within the data.

The University of Miami has taken the leap into the Metaverse and IDSC researchers are at the forefront of Creative Technologies, using code and design to shape our world. Students use AR, VR, and XR immersive technologies to coalesce computing and shape the Metaverse in the new Digital Twins Lab.

"Unrivaled at teaching data visualization, UM has deep coursework in infographics, visualization, cartography, 3D modeling, and advanced programming—all related to journalism."

"Faculty and students will now have access to educational materials, job search platforms, online training, research, and a network of companies working in the immersive space."

Alberto Cairo, PhD
DIRECTOR, VISUALIZATION

Kim Grinfeder
DIRECTOR, CREATIVE TECHNOLOGIES

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healthhub.idsc.miami.edu showcases a developing, novel concept, smart medicine cabinet project that encapsulates and concentrates four main functions: monitoring, treating, communicating, and data analysis.

"Smart Home Health Hub" Reimagined Health Care at Smart Cities MIAMI Conference

The UM Innovation Showcase at Smart Cities MIAMI explored how digital tools, the internet of medical things, and edge analytics are shifting the health care sector overall.

A multi-disciplinary team with expertise in biochemistry, molecular biology, medicine, design, and computer science is developing a concept beyond mainstream smart-home technology that may have been hard to imagine in a pre-pandemic world, but, as a result of evolving technologies, is closer than we think.

Gathered from the College of Arts and Sciences, the Dr. John T. MacDonald Foundation Biomedical Nanotechnology Institute—Bionium, the Miller School of Medicine, IDSC, and the School of Architecture Responsive Architecture and Design Lab (RAD-UM), the team presented a model of interconnectivity between the clinic, hospital, pharmacy, and the home as the new primary site of health care. Reinventing the current hospital model by modifying it as a dispersed network can turn your living space into an interactive, mixed-reality experience that connects to your physician in seconds. This encapsulates and concentrates four main functions: monitoring, treating, communicating, and data analysis. "We think of it as the Swiss Army knife of sensors. It can be customized and connected to appliances you already may have," said Architecture Dean and IDSC Smart Cities Director Rodolphe el-Khoury. "Integrating state-of-the-art technologies with data acquisition and handling—done in a protective way and then communicated, seamlessly, with the physician and health care providers—is a totally novel concept that does not exist," said IDSC Chief Innovation Officer Dr. Yelena Yesha.

Participants

Leonidas Bachas, Sylvia Daunert, Umer Bakali, Christopher Chung, Sapna Deo, Emri Dikici, Rodolphe el-Khoury, Chitvan Killawalla, Donnie Garcia-Navarro, Simona Nagyova, Mitsu Ogihara, Sheng Qian, Gang Ren, Junren Tan, Nick Tsinoremas, and Yelena Yesha

> "Fitbits and Apple Watches tell us *some* information, but are not a holistic, total approach like the smart home health hub. We are going a step further."
>
> -YELENA YESHA

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Smart Cities + Smart Environments

A smart city utilizes information derived from diverse datasets to design and manage sustainable and resilient communities. Integrating data from devices and sensors connected to the Internet of Things (IoT), as well as other applications and platforms, can optimize municipal operations and service delivery, while creating new kinds of experiences and engagement opportunities with residents.

IDSC's powerful resources empower researchers to exponentially expand the reach, diversity, and magnitude of that municipal data in real time to deepen their understanding of the urban ecosystem.

Smart cities research includes data collecting technology as well as data analytics and advanced hardware and software applications. IDSC builds on this research to provide design services for the planning and implementation of smart cities in the region and around the world. Today, IDSC is in a unique position to leverage its computational resources, along with its expertise in physical computing and data analytics, to design the next generation of smart cities and smart environments.

"Technology is not only an instrument for construction, design, management, and workflow, we think of it as ingredient—we are embedding technology into *every* building material to see what happens."

Rodolphe el-Khoury, PhD
DIRECTOR

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Workforce Development

Currently, Miami-Dade County has hundreds of businesses, nonprofits, and government agencies that employ data science professionals. This pool of talent continues to grow as the South Florida region attracts more technology companies.

Recognizing the importance of the growing business technology workforce needs, IDSC has partnered with the Miami-Dade Beacon Council, the area's *key* public-private economic development organization. Working through our Industry Advisory Board, IDSC is compiling local data science job descriptions in order to analyze the requisite skills and knowledge.

The resulting insights are made available to UM and other academic institutions in our community so that curriculum and course offerings can be aligned with industry needs.

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This type of workforce development initiative will support the expansion of local businesses, as well as the relocation of newcomers. It can help businesses understand the nature of the ICT (Information/Communication/Technology) talent pool in South Florida, so they can source the right talent locally. This partnership is a win-win for our community.

"IDSC is building partnerships to develop the skilled STEM workforce of the future."

Mitsunori Ogihara, PhD
DIRECTOR

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Engagement + Outreach

From cybersecurity to applying AI in business, IDSC is launching a wide range of collaborative educational programs to develop data science classes and mini-courses tailored to students planning careers in medicine, business, science, and other disciplines. A new Master of Science in Data Science (MSDS) degree program currently offers six specialty tracks: technical data science, smart cities, data visualization, marine and atmospheric science, educational measurements and statistics, or marketing, and includes a professional internship.

Other new educational opportunities include:

- The IBM Skills Academy offering training in data science, AI, blockchain, quantum computing, and cybersecurity;
- An executive AI course in collaboration with the Miami Herbert Business School; and
- A new undergraduate course "Data Science for the World."

IDSC is also working with students from Ransom Everglades High School interested in data science careers, and with at-risk middle school students from their Breakthrough Miami program. In addition, an articulation agreement with Miami Dade College opens the door to career opportunities for students with a Bachelor's degree to enter the MSDS program and take advantage of the internship placements. IDSC also places postdocs, graduate, and undergraduate students with industry partners to encourage exploration, and for training in translational research.

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Events

Increase your data science savvy by attending an IDSC lecture, workshop, or one of our major annual events:

- Big Data Conference
- Data Citizens: A Distinguished Lecture Series
- Data Intersections
- Meet a Data Scientist Lecture Series
- Smart Cities MIAMI Conference
- VizUM Symposium

Join our mailing list to stay informed on upcoming IDSC events:

idsc.miami.edu/events-calendar

Big DATA CONFERENCE

DATA INTERSECTIONS

Smart Cities MIAMI 2023

VizUM

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