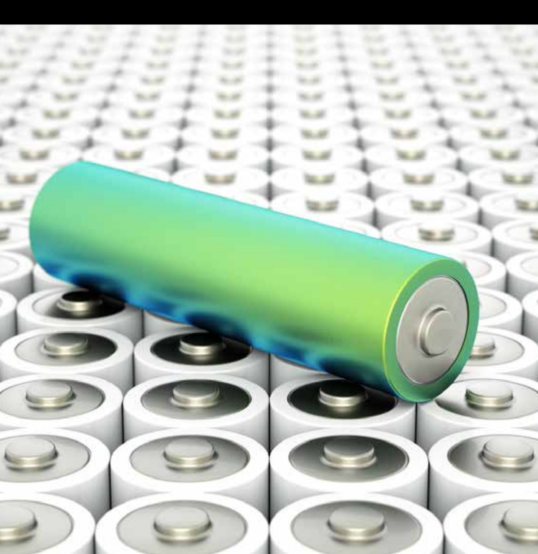
NJIT
New Jersey Institute of Technology

A Top 100 National University

– U.S. NEWS & WORLD REPORT



IN THIS ISSUE

Studying ant colonies to understand mass migrations

Identifying brain biomarkers of ADHD

Addressing grand challenges at the food-energy-water nexus

Research snapshots

Q&A with David Bader

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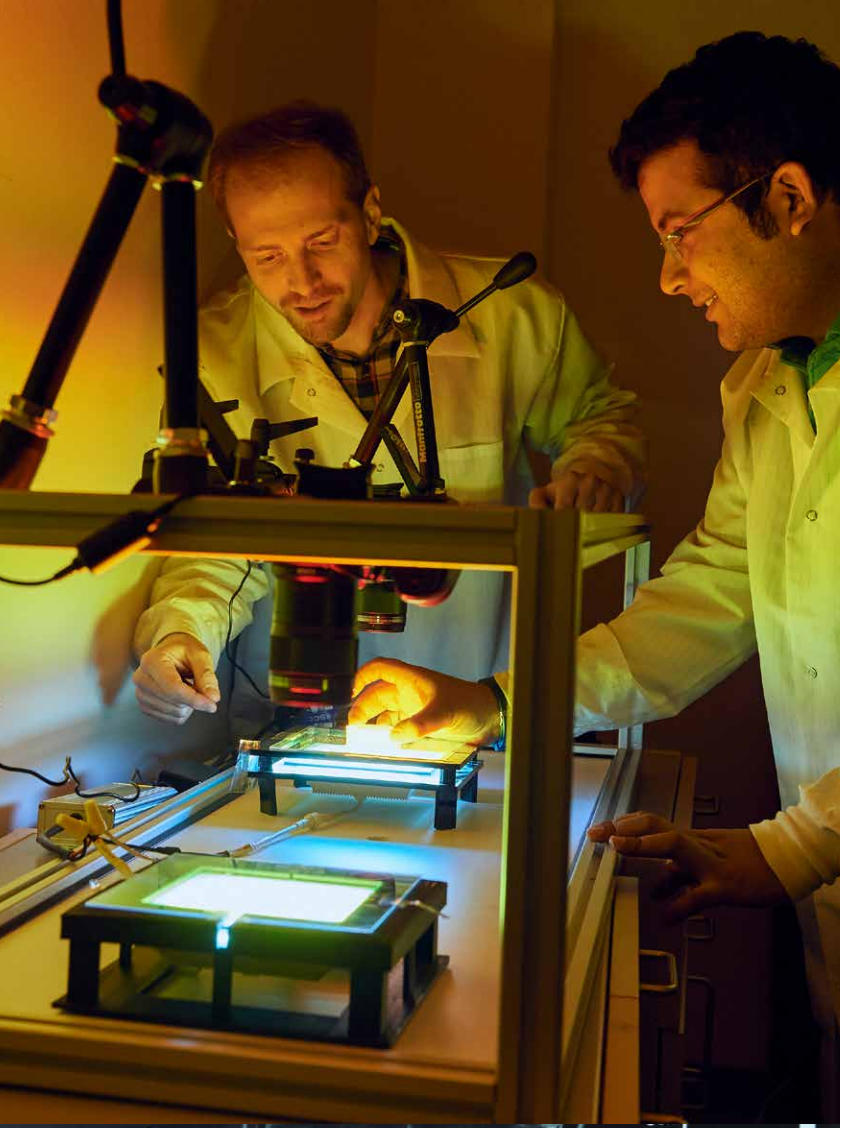
NJIT has been elevated to an "R1" institution
by the Carnegie Classification
of Institutions of Higher Education.

#1

nationally for student upward economic mobility,
according to *Forbes*.



Studying ant colonies to understand mass migrations

Simon Garnier, assistant professor of biology at NJIT, is using ant colonies as a model system to explore ideas that could help U.S. national security analysts detect the start of mass human migrations in different parts of the world and predict their destinations. Funded by the U.S. Department of Defense, the research focuses on how biological systems — like insects, fish, birds — cope with complex, dynamic and uncertain environments by balancing group success and individual survival.

Dr. Garnier's expertise is based on years of investigating how large groups transfer and integrate information and make "intelligent" collective responses to environmental challenges. How is it, for example, that ants regulate the traffic on their trails almost optimally while human beings still get stuck in traffic? And how do slime mold, which possess no brain or central nervous system, construct transportation networks as efficient as those designed by human engineers?

In his interdisciplinary Swarm Lab at NJIT, Dr. Garnier and his team study these questions, developing models designed to help human society anticipate and prepare for what lies ahead.

Identifying brain biomarkers to better treat ADHD

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common childhood neurodevelopmental disorders, affecting an estimated 9.4% of children ages 2 to 17. The cognitive impairments of ADHD often last a lifetime, disrupting behavior at school, work and in personal relationships. Traditionally, a diagnosis of ADHD is reached by observing and assessing symptoms of inattention, hyperactivity and impulsivity.

Xiaobo Li, associate professor of biomedical engineering at NJIT, aims to change this model by using advanced magnetic resonance neuroimaging and analytic techniques to identify the biological markers of ADHD — a critical first step in improving diagnoses and interventional strategies.

As director of the Computational Neuroanatomy and Neuroinformatics Lab at NJIT, Dr. Li specializes in the study of the structural and functional alterations of the brain in children with ADHD. She also studies the differences in the neural signatures of children with ADHD whose parents also exhibit symptoms of the disorder. Dr. Li's research is supported by the National Institute of Mental Health.

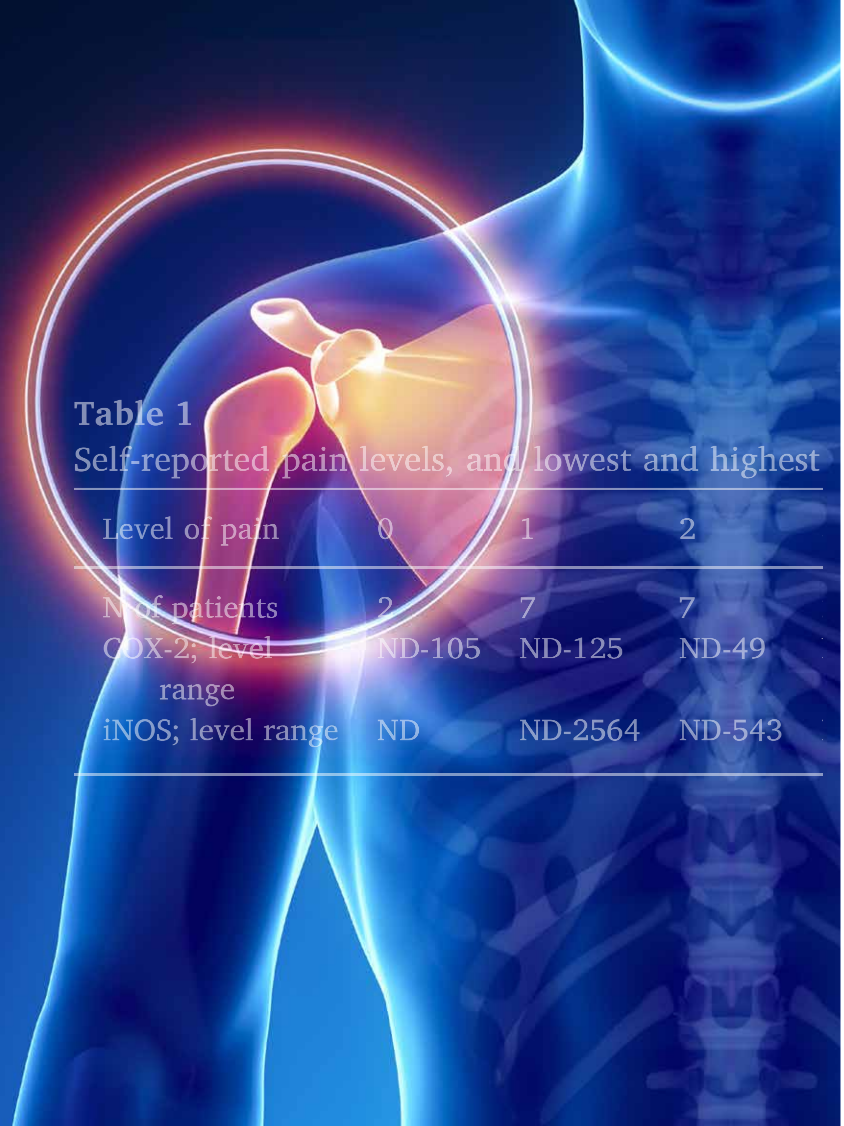


Table 1
Self-reported pain levels, and lowest and highest

Level of pain	0	1	2
No. of patients	2	7	7
COX-2; level range	ND-105	ND-125	ND-49
iNOS; level range	ND	ND-2564	ND-543

Developing biosensors to help doctors assess pain

An estimated 100 million Americans experience chronic pain, with the cost of treatment and lost productivity pegged at well over $600 million annually. Despite the scale of the problem, pain is notoriously hard to objectively measure and evaluate.

Working at the frontier of this critical and costly healthcare issue is **Omowunmi "Wunmi" Sadik**, distinguished professor of chemistry and environmental science at NJIT and an international authority on biosensing technologies. Dr. Sadik and her team's primary research focus today is on biosensors and disease detection and, more specifically, on the development of biosensors to assess pain.

Dr. Sadik's research is particularly relevant to improving emergency room patient care, where pain assessment is vital for effective pain management. By developing and testing new kinds of biosensors to detect specific pain biomarkers — measurable substances in the body linked to objective biological conditions — Dr. Sadik is contributing to the creation of a "pain expression" database with biomarker information for pain analysis in clinical settings.

Using microwaves to eliminate contaminants from water

Viruses and pathogens increasingly threaten global water sources. So do high concentrations of pharmaceuticals, personal care products and potentially endocrine-disrupting compounds. Flushed into our water systems, these contaminants pose new challenges to conventional water treatment.

That's why the research of **Wen Zhang** is so closely watched. Associate professor of civil and environmental engineering and co-director of the Sustainable Environmental Nanotechnology and Nanointerfaces Laboratory, Dr. Zhang has filed a patent for a groundbreaking technology that promises to usher in next-generation water filtration processes.

Dr. Zhang's method improves upon widely used membrane filtration technology by sending microwaves to the filter's membrane surface to enhance contaminant degradation on contact. He and his team are exploring ways to scale up application of this technology in the treatment of drinking water, wastewater and the liquid that leaches from landfill areas. His aim is to demonstrate the technology's feasibility outside the lab as point-of-use water treatment devices for safe drinking water.

Addressing grand challenges at the food-energy-water nexus

As the world's population continues to expand, there is an increasingly urgent demand to balance interconnected resources such as agricultural products, fresh water and fuel. NJIT and Zhejiang University in China are working together to deploy teams of researchers to tackle this complex food-energy-water challenge head-on, and they are doing it with an environmentally sustainable and innovative technology.

Funded jointly by the National Science Foundation and National Natural Science Foundation of China, the research is focusing on rice production. Although the grain currently feeds over a third of the world's population and supplies more than one-fifth of the calories consumed by humans, conventional rice farming is staggeringly water-intensive and water-polluting.

Professors **Mengyan Li** (top), **Lisa Axe** (center) and **Zeyuan Qiu** (bottom) from NJIT's College of Science and Liberal Arts and its Newark College of Engineering are leading the U.S. research effort. Their goal is to develop and test a biologically active filtration system that uses microbes to consume unwanted organic contaminants. This novel technology removes nutrients, pesticides and other pollutants from water discharged after irrigation, effectively purifying and recycling the irrigation water so it can be used again. The technology also has the potential to transform rice production into a sustainable agricultural practice by turning agricultural waste into biochar, which reduces greenhouse gas emissions, and into bio-oil, a renewable energy alternative.

The NJIT research team is concentrating on technological innovations to synthesize novel filter media and investigating robust microorganisms that degrade micropollutants. The Zhejiang University team will then scale up the system for field deployment and oversee production of filter media. The filtration system will first be deployed at select rice production sites in China to test its success, efficiency and cost-effectiveness in water contamination mitigation, food safety assurance, bioenergy production, and the reduction of greenhouse gas emissions. Both research teams will work with local governments, regulatory agencies and farmers on outreach activities to promote the transfer and dissemination of this technology to broader rice farming communities.

$29 MILLION GRANT FOR TRANSLATIONAL RESEARCH

The National Institutes of Health (NIH) awarded a $29 million grant for translational science research to a partnership comprising NJIT, Princeton and Rutgers. Translational science, as defined by the NIH, is "the process of turning observations in the lab, clinic, and community into interventions that improve the health of individuals and populations — from diagnostics and therapeutics to medical procedures and behavioral interventions."

The grant, which will help NJIT and its partners improve healthcare in the state, enables the universities to train the translational science workforce; engage patients and communities in all phases of the translational process; promote the integration of special and underserved populations in translational research; innovate processes to increase the quality and efficiency of translational research; and advance the use of big data information systems.

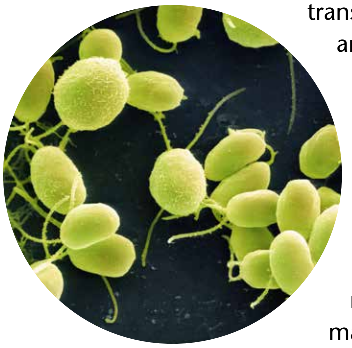
The NJIT team, which includes **Yi Chen** from Martin Tuchman School of Management and **Zhi Wei** from Ying Wu College of Computing, will contribute significant expertise on informatics, machine learning and biostatistics research. The Healthcare Delivery Systems iLab at New Jersey Innovation Institute (NJII), an NJIT corporation, is also participating.

Promoting sustainability and resilience

NJIT's **Center for Resilient Design** is working to further the development of microgrids in the state — an important part of the strategy for sustainable and resilient communities and a clean energy economy. These localized microgrids serve a small network of electrical users, typically buildings that are critical facilities, and can function regardless of whether they are connected to the larger power grid. With support from the U.S. Department of Energy and in partnership with the New Jersey Board of Public Utilities and Rutgers University, the Center is creating an online tool to assist in the procurement and financing of advanced microgrids. This initiative complements the Center's award-winning website, Community Microgrids Planning Academy (microgrids.io), a resource for municipal officials and other stakeholders.

Studying microscopic interactions

Enkeleida Lushi, who studies the dynamics and movement of microscopic swimming cells like bacteria, algae and spermatozoa, is building mathematical models and fast computer simulations to determine what microscopic interactions drive the dynamics and affect the emerging macroscopic and collective behavior. Her aim is to understand how to control particle transport and mixing in biological and synthetic microsystems and build active materials with properties that can be tuned or programmed to perform in predetermined ways. Dr. Lushi's research has broad application to biological and technological processes such as egg fertilization, nanodrug delivery, self-assembled materials, and the bioremediation of oil spills.



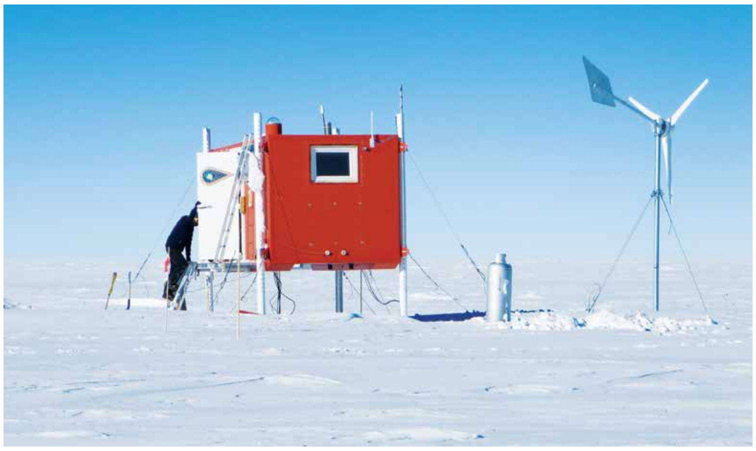
Research S

Using big data to aid criminal justice

With a grant from the National Institute of Justice, **Xinyue Ye** is using big data to aid the investigation and prosecution of sexual assault cases. Applying state-of-the-art software for language processing, machine learning and advanced statistical analyses, the research team is evaluating the narratives of more than 6,300 police reports in one jurisdiction over the span of nearly 20 years. The goal is to understand if and how the language used in an initial police report may impact an investigation's outcome. This research into patterns of "signaling" language will help police officers improve their report writing and interactions with victims and guide supervisors in identifying possible red flags in reports that could affect victim engagement and investigations.

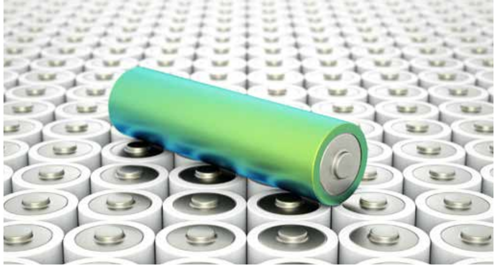
Advancing next-generation polar research

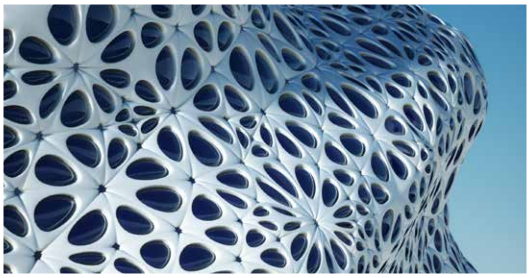
Our technology-centered civilization is increasingly vulnerable to the bursts of electromagnetic radiation, energetic charged particles and magnetized plasma known as space weather. Under the leadership of **Andrew Gerrard** and with support from the National Science Foundation, NJIT upgrades, maintains and manages geospace research instruments deployed over the Antarctic ice shelf. These include photometers that collect light from the Aurora Australis and measure energy from outer space, magnetometers that measure fluctuations in the magnetic field, and GPS receivers. The data is used by NJIT scientists as well as by space weather physicists across the world.



Innovating battery technology

Dibakar Datta is working on computational modeling of a novel technology for battery electrodes that may enable manufacturing of lithium-selenium batteries on an industrial scale. These batteries have the potential to store twice the energy of state-of-the-art lithium-ion batteries and meet ever-increasing energy demands. With a grant from the National Science Foundation, Dr. Datta is collaborating with researchers at the University of Texas at Austin and an industry partner to translate knowledge from the laboratory into manufacturing technology.





Exploring the effect of digital technologies on architecture

The research of **Branko Kolarevic**, dean of NJIT's J. Robert and Barbara A. Hillier College of Architecture and Design, explores how digital technologies are contributing to the 'democratization' of design and, more specifically, what mass customization means for architecture and the building industry. His recent work, for example, looks at the impact of parametric design and digital fabrication, which enable non-designers to mass produce non-standard, highly differentiated products, ranging from shoes and tableware to furniture and even houses.

napshots

Using computational biophysics to gain insights into Alzheimer's

Cristiano Dias studies the structure and molecular driving forces that promote the assembly of certain peptides, the biological molecules found in all living organisms. A better understanding of beta-sheet peptides — commonly associated with Alzheimer's — may provide valuable insights into molecular scale interactions and lead to more effective treatments for the disease. In a current project funded by the National Science Foundation, Dr. Dias' computational biophysics is complemented by experiments conducted by collaborators at the University of Rochester.

Helping senior managers operate more effectively

Oya Tukel, dean of NJIT's Martin Tuchman School of Management, focuses on the development of effective models of project management and scheduling. She studies the relationship between organizational cultures and project performance; the use of project scheduling techniques in other planning procedures, such as materials requirements planning; and the impact of user involvement in information system projects to devise valuable recommendations. Dr. Tukel also uses a quantitative approach to document the importance of knowledge transfer and how learning and forgetting affect performance in a project-driven organization.

$2.8 BILLION
annual economic impact on the State of New Jersey

$165+ MILLION
total research expenditures in FY2019

105+
research institutes, centers and specialized labs on campus

12
National Science Foundation CAREER awards to NJIT faculty members over the past four years

Q&A

David Bader

Distinguished Professor and Director of NJIT's Institute for Data Science

David Bader, distinguished professor of computer science, is the director of NJIT's new Institute for Data Science. His interests lie at the intersection of data science and high-performance computing, with applications in cybersecurity, massive-scale analytics and computational genomics. Dr. Bader works closely with researchers in academia, industry and government to develop the next generation of computing capabilities and has advised the White House on the National Strategic Computing Initiative.

What is NJIT's new Institute for Data Science?

The growing abundance and variety of data we amass gives us unprecedented opportunities to improve lives in multifold arenas — manufacturing, health care, financial management, data protection, food safety and traffic navigation are just a few. The Institute for Data Science (IDS) will focus NJIT's multidisciplinary research and workforce skills training on developing technology leaders who will solve global challenges involving data and high-performance computing (HPC). Within the Institute, collaboration among our existing research centers in big data, medical informatics and cybersecurity and our new centers in data analytics and artificial intelligence will generate data-driven technologies to achieve our goals.

How will NJIT's new Master's in Data Science advance these efforts?

We will train our master's students to think about what questions to ask of data, how to formulate analytics to answer them, to develop high-performance machine learning, and to design new techniques to turn data into real-world intelligence. By engaging confidently with complex data science tasks, our graduates will make a difference in organizations large and small. In business, for example, they will help companies compete in the global economy by harnessing a range of data in new ways: to make clear how policies affect every aspect of their enterprise, to develop transnational supply chains, and to discover efficiencies across systems.

What new capabilities will high-performance computing deliver?

We are developing predictive analytics — the use of data to anticipate the future. Instead of understanding what has happened, we wish to predict what will happen. In cybersecurity, for instance, we would create cyber analytics to defend our critical infrastructure from attack, rather than perform forensic analyses of log files after a breach. In health informatics, we want to detect diseases in their early stages and develop personalized medicines to cure them. In manufacturing, we would identify defects before they cause catastrophic failures.

How must we rethink fundamental aspects of computing to enable these capabilities?

Big data analysis is used to analyze problems related to massive datasets. Today, these datasets are loaded from storage into memory, manipulated and analyzed using HPC algorithms, and then returned in a useful format. This end-to-end workflow provides an excellent platform for forensic analysis; there is a critical need, however, for systems that support decision-making with a continuous workflow. Our HPC systems must focus on ingesting data streams; incorporating new microprocessors and custom data science accelerators that assist with loading and transforming data; and accelerating performance by moving key data science tasks and solutions from software to hardware. These workflows must be energy-efficient and easy to program, while reducing transaction times by orders of magnitude. Analysts and data scientists must be able to ask queries in their subject domain and receive rapid solutions that execute efficiently, rather than requiring sophisticated programming expertise.

Are researchers at the Institute working on these problems?

In collaboration with NVIDIA, a leading technology company that makes GPU accelerators such as the DGX Deep Learning server, we are contributing to RAPIDS.ai, an open GPU data science framework for accelerating end-to-end data science and analytics pipelines entirely on GPUs. The hardware-software co-design for analytics is exciting as we enter a new era with the convergence of data science and high-performance computing. These new analytics pipelines are more energy-efficient and run significantly faster, which is critical for making swift, data-driven decisions.

One of only 32 polytechnic universities in the United States, New Jersey Institute of Technology (NJIT) prepares students to become leaders in the technology-dependent economy of the 21st century. Rated an "R1" research university by the Carnegie Classification®, which indicates the highest level of research activity, NJIT conducts approximately $170 million in research activity each year. NJIT is ranked #1 nationally by Forbes *for student upward economic mobility and #43 out of more than 4,000 colleges and universities by* PayScale.com *for the mid-career earnings of graduates. NJIT is ranked a top 100 national university by* U.S. News & World Report.

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University Heights • Newark, NJ 07102-1982 • 973-596-3000

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