NJIT New Jersey Institute of Technology

FACULTY RESEARCH SHOWCASE

Monday, November 14, 2022

President's Remarks

As one of only 35 polytechnic universities in the United States, NJIT fills a crucial role in a world shaped by technological innovation. The major industries that drive our global economy are technology enterprises at their core, and they rely on scientific breakthroughs and technological innovations to enhance their efficiency and to deliver next-generation solutions to longstanding and emerging needs.

In addition to preparing a highly diverse and exceptionally accomplished student body to become the science, technology, engineering and math (STEM) workforce that fuels our economy, NJIT is an elite research university. We now conduct more than $155 million in applied research annually, solving real-world problems in areas that include civil infrastructure, advanced manufacturing, cybersecurity, transportation, medical devices, clean energy, national defense, health care and many others.

The growth of our research portfolio has earned us the distinction of being designated an "R1" research university by the Carnegie Classification®, which indicates the highest level of research activity. NJIT isone of just three universities in New Jersey — Princeton and Rutgers are the others — to achieve this recognition.

The Faculty Research Showcase offers an overview of the future of research at NJIT, with presentations that introduce our newest faculty and their impressive work to NJIT's research community, in addition to seed grant posters that illustrate the ideas and innovations being produced by new and long-standing members of the NJIT community. Faculty seed grants represent NJIT's commitment to supporting promising research with funding that enables development of a concept into a proposal that can attract significant external resources from the National Science Foundation and the National Institutes of Health, as well as other agencies and foundations.

This day allows us to celebrate the exceptional research and innovation occurring at NJIT while demonstrating the extraordinary ability of our faculty and the importance of their work in improving our world and our lives.

Teik C. Lim
President of NJIT

Transforming the Research Enterprise at NJIT

NJIT celebrated a long-sought milestone in 2019 when the university joined the top tier of research institutions with a designation of R1 by the Carnegie Classification®. But it is on days like today, when we introduce our creative and resourceful new faculty to the campus, that we truly showcase our depth and purpose. This year we welcome new physicists, social scientists, engineers and data scientists who will not only enrich our students' education, but contribute new ideas and inventions that will improve the lives of people everywhere.

Developing knowledge and applying it to the benefit of society requires talent, resources and the encouragement and space for collaboration across disciplines. As we recruit and support exceptional faculty members, we continually strive to provide the environment necessary for their success, includingthe tools that will allow them to translate their ideas into needed technologies in so many spheres, from health care, to civil infrastructure, to the environment. We point with pride to the now eleven NJIT faculty members, including our new president, Teik Lim, who is a Fellow of the National Academy of Inventors.

Each year, we hire around 20 new faculty members as we deepen our capabilities across STEM and other disciplines. They include experts in areas such as machine learning, data analytics, biomaterials and biomechanics, sustainable design, high-powered imaging and new data-gathering techniques. These enterprising scholars bring us not only original research and cutting-edge investigative methods from the country's top academic institutions, but an energizing diversity that renews our traditional disciplines and broadens our research scope. Over the past five years, 16 young researchers have won CAREER awards from the National Science Foundation. By immersing our students in their high level applied research, we in turn empower them to confidently take on the problems of tomorrow.

It is with enormous pride that NJIT showcases its growing research talent in the Ninth Faculty Research Showcase. Some of the interdisciplinary projects you'll hear about today are funded by seed grants from an NJIT research program designed to tackle problems that represent the university's core strengths. Some, such as a project that combines digital technologies and oral history to document urban change in Newark, have a strong teaching component. In it, students will learn novel interdisciplinary teaching and research methods that will help them illuminate the world around them. Our approximately 150 research hubs, including institutes, centers and laboratories, are designed to inspire many more productive partnerships.

We continue to focus on three of the grand challenges inspired by "big ideas" in science and technology identified by federal agencies such as the National Science Foundation, the National Institutes of Health, the U.S. Department of Defense and major organizations and foundations, including the World Health Organization, the Gates Foundation and the United Nations Foundation. They are the life sciences, including health care innovations, systems that enable sustainable societies, and data science and the next generation of cyberinfrastructure. I have every confidence that our new faculty will tackle these challenges with new ideas and energy.

Please join me today in welcoming these brilliant scholars to our community!

Atam P. Dhawan
Interim Provost and Senior Executive Vice President of NJIT

Agenda

9 a.m. - 9:10 a.m.: **WELCOME REMARKS**
Atam P. Dhawan
Interim Provost and Senior Executive Vice President

9:10 a.m. - 9:50 a.m.: **DISTINGUISHED KEYNOTE LECTURE**
Judith A. Sheft
Executive Director - New Jersey Commission of Science, Innovation and Technology

9:50 a.m. - 10:50 a.m.: **NEW FACULTY PRESENTATIONS: SESSION 1**
Martin Tuchman School of Management and Newark College of Engineering

10:50 a.m. - 11 a.m.: **BREAK**

11 a.m. - Noon: **NEW FACULTY PRESENTATIONS: SESSION 2**
College of Science and Liberal Arts and Ying Wu College of Computing

Noon - 1 p.m.: **LUNCH AND NETWORKING SESSION**

1 p.m. - 2 p.m.: **POSTER PRESENTATIONS AND NETWORKING SESSION**
New Faculty and Faculty Seed Grant Recipients

Keynote Speaker

Judith A. Sheft

Executive Director – New Jersey Commission of Science, Innovation and Technology

Judith Sheft is the Executive Director of the NJ Commission of Science, Innovation and Technology. The Commission's mission is to accelerate economic development through science, innovation and technology by stimulating academic-industrial collaboration, encouraging and supporting entrepreneurs and inventors.

Previously she was involved with regional economic and cluster development at the New Jersey Innovation Institute @ NJIT for managing the HealthIT Connections entrepreneurial cluster development program, the NJIT I-Corps Site and the Procurement Technical Assistance Center. She has been engaged with technology/IP innovation and commercialization efforts working with faculty and students to create startup companies and establishing licensing relationships with corporate partners.

She advised external startups at NJIT's high technology/life sciences business accelerator/incubator. She is a former member of the NJ – Israel Commission and serves on the Board of Greater Newark Enterprise Corporation, StartUp Newark, Women's Center for Entrepreneurship Corporation, Einstein's Alley, SheTek and NJEDA Technology Advisory Board.

Research Abstract

Innovation and invention are powerful drivers of economic development and can address numerous societal challenges. The development of the COVID vaccines is one recent example of the power of collaboration on a large scale to amplify and accelerate innovation. Ms. Sheft will discuss mechanisms for individuals and organizations to leverage the power of collaboration building on her experiences in industry, academia and government.

New Faculty

College of Science and Liberal Arts

Julia Hyland Bruno

Assistant Professor of Humanities and Social Sciences

Julia Hyland Bruno joins NJIT from Columbia University, where she was a postdoctoral research scholar at the Center for Science and Society. Her research on animal communication focuses on learned communication systems such as birdsong and human language. The Hyland Bruno Comparative Communication Lab at NJIT will conduct parallel studies of vocal interactions in songbirds and humans, seeking to understand how social animals learn to be social; what patterns, structures and norms characterize their relationships; and how these processes may be uniquely influenced by machines and technology. Accelerated by the COVID-19 pandemic, virtual interactions have become part of life for people of all ages, yet the developmental consequences of virtual communication and learning are largely unknown and difficult to assess. Birdsong development, however, can be studied under controlled conditions in a laboratory setting. The Hyland Bruno Lab aims to use birdsong as an experimental model for investigating developmental socialization and language acquisition in the age of the internet. Hyland Bruno integrates tools and insights from improvisational music and social science in her interdisciplinary research. Her work has been supported by fellowships from Columbia University's Presidential Scholars in Society and Neuroscience, the CUNY Graduate Center's Committee for Interdisciplinary Science Studies and the American Association of University Women. She recently coedited an article collection for the open access journal *Frontiers in Psychology, "Songs and Signs: Interdisciplinary Perspectives on Cultural Transmission and Inheritance in Human and Nonhuman Animals."*

Research Abstract

Digital technologies are rapidly altering the ways in which we relate to one another across both space and time, from the reach and topology of our social networks to the rhythms of our social interactions. What is it like to grow up and learn how to communicate in such an environment? Using laboratory-based studies with zebra finches, highly social songbirds whose songs are socially-learned, my research aims develop an experimental model system for studying the effects of vocal interactivity and its technological alterations on developmental vocal learning and communication.

Lindsay Goodwin

Assistant Professor of Physics

Lindsay Goodwin comes to NJIT from the University Corporation for Atmospheric Research, a nonprofit consortium of colleges and universities that manages the National Center for Atmospheric Research, where she was a Jack Eddy postdoctoral fellow. Goodwin specializes in ionospheric plasma dynamics and the impact of solar-terrestrial physics on the ionosphere. She focuses on two fundamental questions in space physics: How energy from the Sun cascades into the ionosphere and thermosphere, driving ionospheric structures and the global redistribution of plasma; and how space plasmas and neutral particles interact and exchange charges in response to changing ionospheric conditions. To answer these questions, she uses spacecraft, radar, imagers, magnetometers, ionosondes and a variety of models and simulations. She is developing techniques to accurately quantify the scale-sizes of plasma density structuring in the ionosphere in response to solar events, solar parameters, the solar wind and changes in the magnetosphere. These plasma structures are capable of distorting radio signals that travel in the atmosphere, as well as impacting the movement and survivability of spacecraft. Goodwin has published a variety of papers related to solar-terrestrial physics in journals such as *Geophysical Research Letters* and *Radio Science*, and contributed to the book, "Cross-Scale Coupling and Energy Transfer in the Magnetosphere-Ionosphere-Thermosphere System," which is related to the coupling and energy transfer in the Magnetosphere-Ionosphere-Thermosphere System.

Research Abstract

To provide new insights into the relationship between solar and geomagnetic conditions, upper atmospheric plasma structures, and radio wave trajectory at high-latitudes, spectra are developed using a novel Incoherent Scatter Radar (ISR) technique. This technique leverages: 1) volumetric measurements of plasma density, 2) the slow cross-field plasma diffusion at scales greater than 10 km above 200 km altitude, and 3) that high-latitude geomagnetic field lines are nearly vertical. The resulting spectra are of a higher spatial-temporal resolution than has been previously possible with ISRs. By comparing spectra from high-latitude Resolute Bay ISR data to solar and magnetospheric conditions, we have found that although structures 100s of km wide can be prevalent for a variety of geomagnetic conditions, polar cap structures 10s of km are more prevalent during quiet geomagnetic conditions. Furthermore, structures that are 10s of km wide become more dominant near midnight. This presentation will expand on these findings.

Chong Jin

Assistant Professor of Mathematics

Chong Jin joins NJIT from the University of Pennsylvania, where he was a postdoctoral researcher in the Department of Biostatistics, Epidemiology and Informatics. He is interested in the development of statistical and machine learning methods for the integration of multi-omics data. These data, multilayer molecular characterizations of biological systems, offer new opportunities in mathematical modeling to reveal cell types and states underlying the diagnosis and treatment of complex human diseases. Jin applies regression methods, controlling for batch effects, to extract information from sequencing data of heterogeneous tissues, deepening our understanding of biological differences from the tissue level to the cell level using only tissue-level measurements. He has also developed a framework to elucidate the causal effects of multiple omics biomarkers, which are candidates for drug targets in complex diseases such as Alzheimer's. His work has been published in top journals such as *Nature Computational Science*, and he received the Distinguished Student Paper Award from the Section on Statistics in Genomics and Genetics of the American Statistical Association.

Research Abstract

Using Mendelian randomization, we can identify the possible causal relationship between an omics biomarker and disease outcome using genetic variants as instrumental variables. This allows us to prioritize genes whose omics readouts can be used as predictors of the disease outcome through analyzing GWAS and QTL summary data. However, best practices are elusive when jointly analyzing the effects of multiple -omics biomarkers annotated to the same gene of interest. To bridge this gap, we propose powerful combination tests that integrate multiple correlated p-values without knowing the dependence structure between the exposures.

Thi Phong Nguyen

Assistant Professor of Mathematics

Thi Phong Nguyen comes to NJIT from Purdue University, where she was a Golomb Visiting Assistant Professor. Her research areas are inverse problems and imaging – the science of determining from a set of observations the causes that produced them – and numerical methods for solving partial differential equations. In particular, she focuses on developing numerical methods for solving inverse scattering problems, which aim to determine the characteristics of an object based on how it scatters incoming waves. These problems arise in real-life applications, such as non-destructive evaluations to detect defects and medical imaging to identify cancers. By illuminating a probed domain with acoustic, electromagnetic and elastic waves and measuring the response in scattered waves at some distance, the goal is to identify the presence of defects, such as cracks, anomalies and cavities, and, if possible, to find their location and reconstruct their shape. Nguyen has used so-called sampling methods for solving these sorts of inverse problems and applying them to particular projects, such as reconstructing fractures inside a solid body, such as a rock specimen, and reconstructing local defects in periodic media, such as photonic crystals, which manipulate light flow, and nanograss, a synthetic material composed of blades of silicon that can be used in solar cells. Her work has been published in top journals in her niche area, such as *Inverse Problems,* the *Journal of Scientific Computing* and *Computers & Mathematics with Applications.*

Research Abstract

Inverse scattering problems arise in many real life applications such as non-destructive evaluation, medical imaging, geophysical exploration, etc . For instance, illuminating a probed domain with some (acoustic, electromagnetic, elastic) waves and measuring the response (scattered waves) at some distance, the inverse problem is to identify the presence of defects, such as cracks, cavities, anomalies, and if possible, reconstructing their shape and location from the measured data.

To solve such inverse problems, I developed the so-called Sampling Methods. They are fast and efficient methods, based on the construction of an indicator function to test whether each sampling point is inside or outside the defects. This presentation will introduce some results on the application of such inverse problems for two particular projects: The reconstruction of closed fractures inside a finite solid body and the reconstruction of local defects in an infinite periodic layer without any prior knowledge on the periodic structure.

Yao Sun

Assistant Professor of Humanities and Social Sciences

Yao Sun joins NJIT from the University of South Florida, where she was an assistant professor in the College of Arts and Sciences. A computational social scientist, Sun studies collective intelligence, open innovation and open science, virtual groups and virtual communities, and social and semantic networks. She also researches the behavioral and societal impact of virtual reality and artificial intelligence, such as peoples' social behavior in VR environments and the role that AI plays in shaping collective actions. Applications include using AI and VR technologies to build crowd-based platforms to engage citizens in scientific research and facilitate collaborative innovation. She is the co-principal investigator (co-PI) for a pending $5 million National Science Foundation grant studying system-level knowledge, community-based communication and equitable decision-making for compound coastal hazards mitigation. She has been the PI on several internally funded projects studying topics such as collective intelligence and knowledge-sharing dynamics and the relationship between peoples' personalities and their behavior in VR environments. Her research has been published in social science journals such as the *Journal of Knowledge Management* and *New Media & Society*, and won top paper awards from the International Communication Association. Sun was an Annenberg Fellow while earning a Ph.D. in communication at the Annenberg School for Communication at the University of Southern California and a fellow at the Oxford Internet Institute.

Research Abstract

As citizen science and open science increasingly help bring together the public, academic researchers, policymakers, and practitioners to collaboratively address environmental, scientific, and other wicked problems, they have been viewed as having great potential to increase science literacy, empower communities, and create new attitudes and values. However, little research has been done to examine the mechanisms through which the crowd successfully explicates and integrates diverse knowledge to generate innovative ideas. Analyzing 21 online citizen-based open challenges, my studies demonstrate that the crowd tends to be more successful in collaborative knowledge sharing when the members involve in pro-socially motivated interactions and take non-centralized communication positions. My research provides insights into the understanding of citizen science mechanisms as well as offers best practices for the implementation of citizen science and open science in promoting large-scale crowd-empowered innovation and scientific development.

Kristina Wicke

Assistant Professor of Mathematics

Kristina Wicke comes to NJIT from The Ohio State University, where she was a President's Postdoctoral Scholar in the Department of Mathematics. She focuses on mathematical phylogenetics, the mathematical study and theory of the evolutionary history and relationships among groups of species. On one hand, Wicke is interested in studying combinatorial and structural properties of evolutionary trees and networks, such as their balance and symmetry. On the other hand, she studies how phylogenetic methods can be used in areas such as biodiversity conservation by analyzing and developing measures of phylogenetic diversity that can be used to rank species for conservation, based on their position in an underlying phylogenetic tree or network. While motivated by biological questions and applications, her research is focused on graph theory and combinatorics, algorithms and probability theory. Her doctoral studies in biomathematics at the University of Greifswald in Germany were supported by a scholarship from the German Academic Scholarship Foundation, Germany's largest and most prestigious scholarship foundation. She has published 17 peer-reviewed journal articles to date.

Research Abstract

Mathematical phylogenetics is the mathematical study and theory of the evolutionary history and relationships among groups of species. One application of phylogenetics lies in biodiversity conservation, where phylogenetic trees and networks are used to quantify biodiversity by estimating how much "evolutionary heritage" is captured by each species and thus may be lost due to high rates of species extinction. This is formalized by the concepts of phylogenetic diversity, a metric quantifying the biodiversity of a set of species based on their evolutionary relatedness, and phylogenetic diversity indices, measures that quantify the importance of species to overall phylogenetic diversity and provide prioritization criteria for conservation decisions. In this talk, I will give a general introduction to phylogenetics and its use in biodiversity conservation. I will then discuss some recent developments and challenges arising in conservation phylogenetics.

Newark College of Engineering

Elisa Kallioniemi

Associate Professor of Biomedical Engineering

Elisa Kallioniemi comes to NJIT from the University of Texas Southwestern Medical Center, where she was a postdoctoral research fellow, supported by the Oskar Huttunen Foundation, in the Department of Psychiatry. Her research areas are neural engineering and noninvasive electromagnetic brain stimulation. She is developing next-generation therapeutics for psychiatric and neurological disorders, such as depression and stroke, and methods that use brain stimulation as a diagnostic and neuroscientific tool for the same disorders. While a Ph.D. candidate at the University of Eastern Finland, she improved the functional motor mapping methodology that seeks to locate the brain areas that control human movements, making the procedure more accurate, while providing additional information not available through conventional methods. The goal of this methodology is to improve clinical outcomes in presurgical motor mapping, for example, before tumor resection or epilepsy surgery, when the resectable area is close to the brain areas controlling movements. During her postdoctoral training, she showed that the state of brain systems could determine whether an individual with a severe psychiatric disorder would benefit from specific brain stimulation therapies, which would improve patient selection for these treatments. She has received fellowships from the Instrumentarium Science Foundation, Orion Research Foundation sr and Finnish Cultural Foundation, among others. Columbia University and Cornell University named her a "Rising Star."

Research Abstract

Transcranial magnetic stimulation (TMS) is a non-invasive electromagnetic brain stimulation method that can be used to study and modulate the brain for therapeutic purposes. Therefore, developing TMS is of great importance as it could provide biomarkers that tell us about the presence or trajectory of a disorder, response to therapeutic intervention, or neural plasticity and provide therapeutic options for individuals who cannot tolerate or do not benefit from available pharmaceuticals. In this talk, I will discuss the highly interdisciplinary brain stimulation research program I am developing at NJIT, the current research projects, and future directions.

Oladoyin Kolawole

Assistant Professor of Civil and Environmental Engineering

Oladoyin Kolawole joins NJIT from Hope College, where he was a faculty fellow teaching fluid mechanics. He integrates rock mechanics, energy engineering and biotechnology to investigate how rocks and rock-like materials deform or fail in response to changes in stress, pressure and temperature, with applications focused on sustainability, energy and the environment. While a Ph.D. candidate and postdoctoral researcher at Texas Tech University, he developed the concept of "biogeomechanics" in the emerging field of biogeotechnics, which focuses on microbial actions in rocks intended to change their properties to enhance oil and gas extraction and, following that, carbon storage. To improve extraction, he injects microbes into deep underground rocks that make them weaker; to augment storage, different microbes strengthen rocks. Their response indicates the associated level of difficulty and risk for both operations. He also researches improvements in the design and efficiency of surface structures, such as building foundations and dams, near-surface structures, such as rock slopes and surface excavations, and underground structures, such as tunnels, pipelines and open-pit mines, as well as methods to prevent leaks from underground fluid storage. He has a pending patent. Kolawole was the first early-career recipient of the Distinguished Service Award from the American Rock Mechanics Association. He volunteers as a peer reviewer for Nature Scientific Reports, Rock Mechanics and Rock Engineering, and was recently appointed to the Committee on Geological and Geotechnical Engineering at the National Academies of Sciences, Engineering and Medicine.

Research Abstract

The world is currently being threatened by geotechnical-related hazards and extreme weather conditions due to climate change. The mitigation of these hazards and resilience of our geo-infrastructures and environment requires technical solutions at the interface of rock mechanics, geotechnical engineering, geosystems engineering, and sustainable geo-resources. Thus, an interdisciplinary approach is required for the efficient development of new frontiers in engineering technology to mitigate failures in near-surface and underground infrastructures, reduce the impact of climate change, and improve geo-energy recovery and storage. This presentation will briefly show how I integrate various scientific fields to advance geotechnical-related hazard mitigation related to geomaterials, net-zero carbon emission, and geo-infrastructure integrity.

Marcos Netto

Assistant Professor of Electrical and Computer Engineering (Spring 2023)

Marcos Netto comes to NJIT from the National Renewable Energy Laboratory (NREL), where he was a research engineer and a recipient of an NREL Director's Postdoctoral Fellowship. He focuses on understanding, characterizing and controlling the dynamics of electric power grids to facilitate the integration of renewable energy sources at a significant scale. He was the principal investigator on a project that pioneered the implementation at NREL of a data analytics platform based on streaming data, suitable for developing and testing modern artificial intelligence methods to aid in the real-time operation of power grids. While a Ph.D. candidate at Virginia Tech, he developed numerical methods that use data from a specific class of sensors to inform power grid operators about the system stability margin, a critical piece of information to ensure safe and reliable operation. His work appeared in the "Best Papers" session of the IEEE Power and Energy Society General Meeting and received a student contest award. In addition to his research experiences, Netto worked in private industry for seven years for power transmission system operators, software developers and consulting firms in Brazil and the United States. He led a study, for example, that looked into alternative technologies that could cost-effectively increase the transmission capacity of renewable electricity from the Midwest to the eastern United States without requiring the construction of new transmission lines, thereby averting social and environmental impacts.

SangWoo Park

Assistant Professor of Mechanical and Industrial Engineering

SangWoo Park joins NJIT from the University of California, Berkeley, where he received a Ph.D. in industrial engineering and operations research. He researches optimization, control and machine learning with a focus on power and energy systems. He is also interested in technologies to integrate renewable energy into the power grid, energy policies and markets. During his doctoral pursuit, he designed and analyzed optimization algorithms that help operate large-scale power systems in a safe and economic manner. For example, he developed tools that use data coming from sensors to estimate the state of the power network and that are resilient against faults and cyberattacks. He also developed a homotopy-based method that can find globally optimal solutions of nonconvex optimization problems, which was applied to hardening power systems against faults and failures and improving their survivability. He is the recipient of the "Best Student Paper" award at the 2020 American Control Conference, the Marshall-Oliver-Rosenberger Fellowship at UC Berkeley and the Outstanding Graduate Student Instructor award at Berkeley.

Research Abstract

To safeguard the power system against critical failures, the power network must be constantly overseen so that, if needed, appropriate actions can be taken. This monitoring is achieved via real-time state estimation that aims to recover the underlying system voltage phasors, given measurements and a system model that encodes the network topology and other specifications. To ensure an accurate state estimation, it is essential to have the capability of detecting bad data and faults in the network. Several sources of bad data include miscalibration of measurement devices, cyber-attacks, topological and parameter errors in the model. There are also different types of faults that can appear in a power system, such as open-circuit and short-circuit faults. We use a combination of optimization and state-of-the-art machine learning to detect and classify different types of bad data and faults in the power system. Our approach improves on existing methods and strengthens the resiliency of the grid.

Bo Shen

Assistant Professor of Mechanical and Industrial Engineering

Bo Shen comes to NJIT from the Smart Manufacturing Analytics Research & Technology Lab in the Grado Department of Industrial and Systems Engineering at Virginia Tech, where he was a doctoral student in industrial and systems engineering. His research is at the interface of data science and artificial intelligence and advanced manufacturing, with a primary focus on additive manufacturing, or 3D printing. During his Ph.D. program, he developed advanced machine learning methods for online monitoring of additive manufacturing processes based on real-time sensor data, and quality assurance in smart additive manufacturing. For example, based on the data from state-of-the-art sensors, such as in digital microscopes, 3D scanners, thermal cameras, high-speed X-ray cameras, and from simulation software, he developed real-time methods to extract important process features. These features can be further used to develop process control algorithms for improving the quality and productivity of additive manufacturing, so that, based on its improved performance, complex geometries and simplified fabrication, most products can be manufactured this way. He has received several "Best Paper" awards from the Institute for Operations Research and the Management Sciences and the Institute of Industrial and Systems Engineers.

Research Abstract

Advanced manufacturing technologies together with data science and artificial intelligence, are transforming manufacturing from limited factory floor automation to fully autonomous and interconnected systems. Driven by edge computing, the Industrial Internet of Things (IIoT), sensors and other smart technologies, data collection, communication, analytics, and control are infiltrating every aspect of manufacturing. The data provides excellent opportunities to improve and revolutionize manufacturing for both quality and productivity. Despite the massive volume of data generated during a very short time, approximately 90 percent of data gets wasted or unused. The goal of sensing and data analytics for advanced manufacturing is to capture the full insight that data and analytics can discover to help address the most pressing problems. Along with this goal, my current research area focuses on developing advanced machine learning methods for online process monitoring and quality assurance in smart additive manufacturing.

Jongsang Son

Assistant Professor of Biomedical Engineering

Jongsang Son joins NJIT following postdoctoral training at the Shirley Ryan AbilityLab (formerly the Rehabilitation Institute of Chicago) and Northwestern University. He studies the mechanisms of inefficient muscular contraction in chronic stroke survivors, using biomechanical and neurophysiological experimental tools, computational neuromuscular models and ultrasound imaging techniques. His research priorities are to understand the underlying neuromuscular mechanisms of motor impairments in broad clinical populations, including the aging and people who have experienced strokes and spinal cord injuries; to quantify neuromuscular properties in a noninvasive, practical way; and to investigate neuromuscular adaptations in response to various sensorimotor stimulations. Ultimately, he hopes to translate his discoveries into practical interventions that can help people with chronic diseases improve their motor function during activities of daily living. He was a Marry Switzer Fellow supported by the National Institute on Disability, Independent Living and Rehabilitation Research Switzer Research Fellow Program and a Yamaguchi Medal winner (Young Investigator Award) from the Asian-Pacific Association for Biomechanics.

Research Abstract

Muscle weakness is one of the severe motor impairments that are very commonly observed in broad clinical populations including stroke. The voluntary weakness of muscle results in the disuse of the muscle, and the muscle becomes weaker progressively unless otherwise treated appropriately. Unfortunately, there is no effective care for muscle weakness currently, it is thus critical to better understand neuromuscular mechanisms underlying muscle weakness and movement impairments. In this presentation, we will briefly discuss what neuromuscular factors change following stroke and how these changes are associated with muscle performance measures. Future directions to describe neuromuscular adaptations in response to sensorimotor stimulations as well as to quantify human movement performance based on machine-learning algorithms will be discussed as well.

Petras Swissler

Assistant Professor of Mechanical and Industrial Engineering

Petras Swissler comes to NJIT from the Northwestern University Center for Robotics and Biosystems. His primary research interest is robotic self-assembly, a process analogous to how some ants form bridges using their own bodies. He works toward a future where on-demand robotic structures are practical, if not commonplace: humanitarian efforts could deploy swarms of robots to quickly rebuild infrastructure, reducing the time needed to provide critical aid; robot swarms could form temporary structures such as construction scaffolding to reduce human effort on non-value-added work, while also reducing material costs, as such structures can self-disassemble for reuse. He approaches these problems by developing novel robot hardware, as well as the algorithms necessary to build such structures, and his work focuses on how to bring principles of "messy" and on-the-fly self-assembly seen in nature to robotic systems, which are typically highly planned and rigidly constrained. He plans to continue this convention-challenging work at NJIT, including research at the nexus of manufacturing, biology and robotics, as well as the development of low-cost educational robotics. He received the "Best Student Paper" award at the 2021 Distributed and Autonomous Systems conference for his development of a novel robotic algorithm, and recently received a patent for a novel robotic attachment mechanism.

Research Abstract

Cooperation enables collectives to perform far beyond the capabilities of their individuals: how do we bring these evident benefits to the world of robotics? This is the core question of my work and the field of swarm robotics in general. My focus is on how this cooperation could enable robots to join their bodies to form structures, similar to how some ants form bridges, chains, and towers. In the future, robots could rebuild or reinforce infrastructure after disasters, self-assemble and self-disassemble temporary or one-off structures, and form and reform tools and objects perfectly-tailored to any individual task. Here, I present some of the work I have done towards this future. First, I introduce the FireAnt robot, which is able to autonomously climb and attach to arbitrary arrangements of like robots. Second, I introduce the ReactiveBuild algorithm, a set of behaviors enabling robots to self-assemble robust, ad hoc structures.

Martin Tuchman School of Management

Ajim Uddin

Associate Professor of Financial Technology

Ajim Uddin recently completed a Ph.D. in Business Data Science at New Jersey Institute of Technology. His research area is FinTech and the application of machine learning to finance, with a special focus on financial networks – the connections among companies through personnel, investments, supply chains and market return. Using advanced machine learning techniques, he intends to learn the latent representation of these networks and discover how network connections influence the market price of financial assets. He is developing a dynamic graph-learning framework for asset pricing and incorporating signed networks, meaning positive and negative connections, in equity pricing models. He is also working on understanding the influence of network connections among decision-makers in the financial decision-making process. This includes designing a network projection model to examine how being connected to more managers or connected to prominent managers influences institutional investors' herding behavior and portfolio performance. His work has been published in peer-reviewed journals such as *Finance Research Letters* and *Quantitative Finance.* He also received the "Best Contribution to Theory" and "Overall Best Conference Paper" awards at the 51st Annual Conference of the Northeast Decision Sciences Institute.

Research Abstract

This paper proposes a novel bipartite network projection model to capture the network centrality of fund managers from their equity connections. We show that the proposed alpha centrality is better at tracking the network evolution over time than alternatives. This data-driven centrality allows us to circumvent the data limitation on exact linkages between managers and examine the importance of managers centrality on their investment performance. There is a positive relation between managers network centrality and investment performance. The results are consistent for different time periods and robust after multiple controls. We also uncover an inverted U shape herding behaviors of managers, which suggests that both central and non-central managers more likely make independent investment decisions, whereas the middle group leans toward herding.

Jinghua (Carolyn) Wang

Associate Professor of Finance

Jinghua (Carolyn) Wang joins the permanent faculty at NJIT from the Martin Tuchman School of Management, where she has been a visiting assistant professor in finance. Prior to NJIT, she was an assistant professor at the University of Wisconsin, Pacific Lutheran University and Stockton University. She uses machine learning methods and time series models to evaluate connectedness – causality relationships among financial assets in equity, bond, energy and cryptocurrency markets – and to forecast prices by analyzing driving factors in financial markets, such as interest rate fluctuations, that can destabilize the market and cause price shifts for particular assets. The goal is to help market practitioners enhance their understanding of asset pricing, which is affected by a variety of variables, from macro and microeconomics, to politics, to investment behavior, to science and technology, and to provide policy makers with practical suggestions on how to monitor and stabilize markets. Before entering academia, Jinghua worked in private industry for Fortune 500 companies, such as the Bank of Montreal, where she served as a quantitative equity research analyst. She has published more than 10 articles in peer-reviewed journals such as the *International Review of Financial Analysis* and *Economic Modelling*, as well as a book chapter on corporate social responsibility. She won research awards including the “Karen Hille Phillips Regency Advancement Research Award” and the “Dean’s Excellence in Research Award” at PLU. She is the faculty mentor for the CFA (Chartered Financial Analyst) Research Challenge team at NJIT.

Research Abstract

We investigate the predictabilities of the thirteen economic policy related uncertainty indices derived from the various measures on Bitcoin returns using machine learning algorithms. Based on the analysis on uncertainty indices, we find that Singapore economic policy uncertainty (SEPU) impact the most on Bitcoin returns. Financial crises uncertainty and world trade uncertainty are important features following SEPU. The empirical results reveal an interesting finding that the predictabilities of uncertainty indices derived from the international trade related category is stronger than other categories in the study. We also find that the impact from the internet-based uncertainty is stronger than the uncertainty indices derived from the newspaper-based and reports-based measures on BTC returns. The results are tested by the various machine learning methods.

Ying Wu College of Computing

Mengnan Du
Assistant Professor of Data Science (Spring 2023)

Mengnan Du comes to NJIT from the big data lab at Baidu Research, where he was a visiting scholar. He recently completed a Ph.D. in computer science at Texas A&M University, where his research focused on the explainability, fairness and trustworthiness of AI. Du develops explainable tools and techniques that enable human users to have more confidence in the predictions made by AI systems that interact with them, such as recommender systems and medical diagnoses. He and his team proposed a novel explainability algorithm to show how machine learning models make predictions, allowing for the efficient calculation of explanation for machine learning models, significantly reducing computational complexity, and allowing for the real-time delivery of model explanations to human users. This technology will be deployed by a technology company to explain to end-users why particular newsfeed advertisements are shown to them. Du has also developed mitigation algorithms that discourage the model from capturing fairness-sensitive information in order to reduce bias and discrimination in machine learning models towards underprivileged groups. He has published more than 40 papers in top publications on machine learning, including a paper on explainable AI that was highlighted on the cover page of *Communications of the ACM*.

Martin Kellogg
Assistant Professor of Computer Science

Martin Kellogg joins NJIT from the University of Washington, where he earned a Ph.D. in the Paul G. Allen School of Computer Science & Engineering. His research focuses on making software verification – that is, using math to prove facts about what a program will do when it is run – practical for every developer, by making it a standard part of every developer's toolkit in the way that most developers today use techniques such as unit testing or code review. Practical software verification increases the reliability and security of software by preventing entire classes of software errors. For example, Kellogg is developing new, more practical verification techniques that guarantee the absence of security vulnerabilities caused by malformed object initialization, array bounds errors that might lead to buffer overflow attacks, and denial-of-service attacks against web servers caused by resource leaks. Verification tools based on his work that prove properties related to security, compliance, and program correctness have been deployed at large technology companies, including Amazon Web Services. His work has been published in papers at annual conferences such as the International Conference on Software Engineering and the Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering.

Research Abstract
Program verification is the process of using math to prove that a program does or does not satisfy some property. Proponents of automated program verification (including me!) have long argued that easy-to-verify code is also simple for humans to read and understand - and, consequently, that using verification tools to guide software development has positive side-effects for human readers. We set out to test this hypothesis empirically: we applied four verification tools to a corpus of 231 short Java programs used in prior studies of human code understanding. We correlated how easily the verifiers figured out what the code was doing with the metrics collected from human subjects in prior studies (like how understandable a human rated the code or how long they took to understand it) and found a promising trend: for 13 of the 20 considered metrics, we could establish a correlation in the expected direction.

Sooyeon Lee

Assistant Professor of Informatics

Sooyeon Lee comes to NJIT from Rochester Institute of Technology, where she was a postdoctoral researcher in the School of Information in the Golisano College of Computing and Information Sciences. Her research is in the fields of human-computer interaction and human-AI interaction, with a focus on accessibility for people with a range of abilities. Her goal is to empower and augment capabilities and promote inclusive experiences in both personal and social spaces through new technologies. She investigates and designs novel technologies and AI-based applications that address barriers in technology use, information access and social participation in order to support people with disabilities. While conducting design research at Uber, she built an accessibility foundation for deaf and hard-of-hearing people to enable them to work in the gig-economy as drivers. At Google, she developed a hardware design framework and guidelines to make the company's hardware products accessible to users with all types of sensory and physical abilities, as well as to people from diverse cultures, genders, ages and socioeconomic levels. Her work has been published in top-tier journals and conferences, including the ACM Conference on Human Factors in Computing Systems (CHI) and the ACM SIGACCESS Conference on Computers and Accessibility. She was one of the top five authors with the most papers accepted to the 2022 ACM (CHI), where she served as an associate chair for the conference.

Research Abstract

Over one billion people in the world live with some type of disability. Many of them experience barriers in accessing information or using technologies, which can limit social interactions in both physical and digital spaces. My research goal is to address these accessibility barriers by investigating emerging technologies and leveraging AI technologies in designing novel and innovative applications and systems. The AI based hand-guide mobile application for a non-visual object acquisition for blind individuals and American Sign Language video anonymization application enabled by AI based face disguise technology for deaf individuals are the examples of such research works. My research will continue focusing on increasing accessibility and will be extended to consider a broader and more diverse group of people with different disabilities and needs through a design of AI-based application and human-AI interaction, as well as the use of a multidisciplinary and co-design based collaborative research approach.

Cong Shi

Assistant Professor of Computer Science

Cong Shi joins NJIT from Rutgers University, where he received a Ph.D. in Electrical and Computer Engineering. His research interests span security and privacy, mobile computing and sensing, and security in machine learning and artificial intelligent systems. His work on the use of off-the-shelf WiFi devices, such as smartphones and smart TVs, to sense users' movements and unique behaviors, led to fellowships at Cisco and Siemens Corporate Research. At Cisco, he investigated and quantified the sensitivity of WiFi signals from access points deployed at the company to human dynamics, such as walking speed and direction; at Siemens, he designed a device-free user authentication system that captures unique behaviors by leveraging WiFi signals from smart devices. The goal is to advance the design of next-generation WiFi technology that will equip smart devices with new functionalities to prevent unauthorized access. Shi also investigates security vulnerabilities in emerging augmented and virtual reality platforms, such as headsets. He studies, for example, how voice command features on virtual reality headsets can lead to privacy leakages, known as eavesdropping attacks, in which hackers can use headsets with built-in motion sensors to record subtle speech-associated facial dynamics to steal sensitive information communicated via voice command, including credit card data and passwords. His work has been published in refereed conference papers at venues such as the ACM Computer and Communications Security conference and the journal *IEEE Transactions on Mobile Computing.*

Research Abstract

With the advancement of mobile technologies, mobile devices play an important role in enabling many emerging applications, such as augmented reality (AR)/virtual reality (VR), voice assistant systems, human-computer interactions (HCI), through combining various sensing and machine learning techniques. My research explores the security vulnerabilities in the sensing interfaces and built-in machine learning models, with the hope of addressing these inherited security issues and bringing trustworthiness to end users. My research work also explores emerging sensing modalities (e.g., acoustic, vibration, visible lights, and WiFi) to enable convenient and secure interactions with mobile systems, by developing authentication schemes and defense techniques against various attacks. I am also seeking contactless healthcare monitoring techniques, including personalized fitness assistant and multiple people vital sign monitoring, which are crucial to maintain health and wellbeing of people, especially under the COVID-19 crisis.

Lijing Wang

Assistant Professor of Data Science

Lijing Wang comes to NJIT from the Computational Health Informatics Program at Boston Children's Hospital and Harvard Medical School, where she was a research fellow. She is interested broadly in computing for social good, applying machine learning, deep learning and natural language processing (NLP) to solve problems in such diverse domains as epidemics, clinical analysis, bioinformatics and public health. While earning a Ph.D. at the University of Virginia, she was part of a multidisciplinary team organized by the Centers for Disease Control and Prevention to conduct COVID-19 forecasting. She led the development of methods related to the use of deep-learning techniques to forecast disease trajectories, such as short-term predictions of case count, peak time and peak intensity. She combines deep learning with theory-based causal models that simulate disease transmission among a population to better understand disease spread and improve forecasting accuracy, while also explaining the predictions of forecasting models. As a research fellow, she explored fine-tuning methods for entity recognition and relationship extraction from clinical narratives in electronic medical records, using NLP techniques. Her work has been published in papers at top conferences, such as the AAAI Conference on Artificial Intelligence, and in journals such as *Advances in Neural Information Processing Systems.*

Research Abstract

Infectious diseases, such as seasonal influenza, Zika, Ebola, and the ongoing COVID-19, place a heavy social and economic burden on our society. Producing timely, well-informed, and reliable spatiotemporal forecasts of the epidemic dynamics can help inform policymakers on how to provision limited healthcare resources and develop effective interventions. My research focuses on deep learning-based methods that incorporate spatiotemporal features, theory-based mechanistic models, and ensemble techniques for a better understanding of disease spreading and improving forecasting accuracy and explainability. This talk presents several works evolving around deep learning techniques for reliable epidemic forecasting. The talk will conclude with a discussion of a current research topic: transfer learning for clinical information extraction. We explore a variance decomposition-based justification criteria to examine whether large pretrained neural models (e.g., RoBERTa) in a fine-tuning task are generalizable enough to have low bias and variance.

Mengjia Xu

Assistant Professor of Data Science (Spring 2023)

Mengjia Xu joins NJIT from the Massachusetts Institute of Technology, where she was a postdoctoral research fellow at the McGovern Institute for Brain Research with a joint postdoctoral appointment in the Division of Applied Mathematics at Brown University. Her research interests lie at the intersection of computer science, medical imaging and computational neuroscience, focusing in particular on novel machine learning methods and the optimization of deep neural networks to better understand cardiovascular disease. Other applications include the classification of red blood cells in sickle cell anemia; the detection and characterization of retinal microaneurysms in diabetic patients' retinal eyes; and prediction of early stages for neurodegenerative disorders, such as Alzheimer's disease. She developed novel probabilistic graph embedding methods for predicting early-stage Alzheimer's progression and evaluating the effects of cognitive interventions with MEG and fMRI brain network imaging. The goal is to develop biomarkers to enable early diagnosis and preventative interventions, and to enhance the management of Alzheimer's at the preclinical phase. While a Ph.D. student at Northeastern University in Shenyang, China and at Brown University, Xu developed a novel AI system to automatically detect defective red blood cells from video data and to classify the severity of sickle cell anemia. She has published her research in top journals such as *PLOS Computational Biology*.

Faculty Seed Grant Recipients

Pramod Abichandani
Assistant Professor of Applied Engineering and Technology

Multi-Modal Image Fusion for Autonomous Counter SUAV Systems

Farid Alisafaei
Assistant Professor of Mechanical and Industrial Engineering

Cells in the body are surrounded by a complex fibrous network, called the extracellular matrix (ECM), which provides biochemical and structural support for cells. Aging or diseases such as fibrosis and diabetes are known to alter the physical properties of the extracellular matrix. Importantly, cells respond to these changes in the physical properties of their extracellular environment by adjusting a wide range of their biological functions such as migration, proliferation, differentiation, and gene transcription. Understanding how cells sense the changes in the physical properties of their environment requires an accurate measurement of these properties. However, conventional methods can only measure the physical properties of the matrix at large scales (macro levels), while cells interact with their surrounding matrix at significantly smaller scales (micro levels). Our preliminary studies show that the properties of the extracellular matrix at micro levels can be significantly different from the macro properties, and therefore conventional testing methods may not be able to report the actual stiffness that cells sense in the body. Using a highly integrated experimental and theoretical approach, we aim to measure the actual matrix's physical properties that cells sense in the body and to elucidate the mechanisms that contribute to the difference in matrix physical properties at macro and micro scales.

Shaahin Angizi
Assistant Professor of Electical and Computer Engineering

The large number of Artificial Intelligence-enabled Internet of Things (IoT) devices consist of sensory imaging systems that enable massive data collection from the environment and people. However, insufficient computing ability of state-of-the-art 'brain' (i.e., processor and memory) of small area/power-restricted IoT devices and memory/compute-intensive AI computing algorithms, prevent AI methods from being widely deployed in edge devices. Meanwhile, in most cases, large portions of the captured sensory data are redundant and unstructured, so data conversion of such large raw data at the sensor side, transmission, and computation in a back-end processor leads to a huge gap between meets and needs. This collaborative proposal achieves preliminary data to enable a smooth transition from the current cloud-centric IoT approach to a data-centric approach, whereby the mobile edge devices can perform computation close to the sensor in cache remarkably reducing the power consumption and latency of data transmission to a back-end processor.

Rayan H. Assaad

Assistant Professor of Civil and Environmental Engineering

One of the issues currently faced in the smart real estate field in general and the shared economy in specific is trust between providers and users of the shared product/service. Thus, this project aims to pave the way for transforming traditional real estate practices into smart real estate whereby both the providers and the users have fewer, or ideally no, regrets for their rental decisions in the shared economy environment. The significance of this project lies by leveraging smart IoT technologies to establish mutual trust between providers and users in a shared economy, which will improve utilization of shared products/services, allocation of resources, pricing rationalization, and rental morality. The expected outcomes of the research include: 1) an intelligent IoT prototype to collect and share real-time information in the "shared economy" environment; 2) quantification of the reliability of the end-user (i.e., room renter) based on the IoT collected information; and 3) a dynamic-pricing model for room condition fee based on the renter reliability index. Different from the traditional shared economy model, which allows price adjustments only based on the terminal room condition, the proposed IoT model allows to track the condition variations over the renter's entire stay. This project allows reliable information to be available and accessible by the stakeholders of the shared economy in real-time to facilitate the decision-making process.

Alexander Buffone

Assistant Professor of Biomedical Engineering

Recruitment of neutrophils from the blood is the "first line of defense" against inflammatory insult. Without precise control of neutrophilic recruitment, inflammation can eventually lead to chronic inflammatory diseases. O-glycans, polysaccharides expressed on neutrophil cell surface receptors, have been implicated in the initial interactions with the activated endothelial surface. Precise control of these O-glycans would allow for the "tuning" of cell recruitment to control the number of migrating neutrophils. The goal of this proposal is to evaluate two molecular targets (ST3Gal-1 and -2), which can help neutrophils to increase the amount of O-glycans on the neutrophil cell surface and in turn lead to increased recruitment to the sites of inflammation. We will make the knockouts in our neutrophils and quantify the changes in overall O-glycan structure and neutrophil recruitment. We expect that the loss of these targets will increase O-glycans on the neutrophil surface, making them recruit in higher numbers.

Aichih Jasmine Chang

Assistant Professor of Business Data Science

The level of global interest in plastic production, consumption and waste recycling has soared in recent years. Governor Murphy signed the bill S2515/A4676 into law recently in Jan. 2022 to increase the recycled content of plastics in a variety of packaging products. To propel the plastic flowing through the supply chain loop, we propose two potential tools: (1) Data Science, and (2) Blockchain Technology. In terms of Data Science, we propose to apply Text Mining, sentiment analysis and data visualization to analyze the plastic data retrieved and collected from public and private data sectors, as well as social media (e.g., Tweeter). In terms of Blockchain Technology, we shall (1) examine how the token and cryptocurrency incentivize consumers to pick up plastic waste via sentiment analysis; (2) study how the environmental, social, and governance (ESG) multiple-objective utility can be maximized via optimization model.

Hao Chen

Professor of Chemistry and Environmental Science

In recent years, our laboratory has developed coulometric mass spectrometry (CMS), a conceptually new approach of using electrochemistry (EC)-assisted mass spectrometry (MS), for absolute quantitation for both peptides and proteins, without using any standards or isotope-labeled peptides. However, we are using a commercial electrochemical flow cell which has a relatively large electrode (e.g., 6 mm ID glassy carbon) with a large dead volume (ca. 1 µL) which has a high electric current background of several hundreds of nano amperes. It leads to a limitation of our CMS quantitation sensitivity to sub-picomole level for proteins and peptides. We are building a microchannel electrochemical cell with microelectrodes so that we could improve CMS sensitivity down to sub-femtomole level, which will significantly broaden the application of CMS in proteomics research to quantifying disease biomarker proteins.

Linda Cummings

Professor of Mathematics

Assembly of nanoscale liquid metal alloys: This interdisciplinary project concerns modeling, simulations and experiments on liquid metal films at the nanoscale. The experiments involve the application of laser pulses to melt solid metal films deposited on silicon substrates: while in the liquid state the metals evolve (flow) and form patterns that remain as solid objects after the laser heating ceases and the metal resolidifies. These objects (a typical example is a semi-spherical nanoparticle) are of importance for a number of applications. Our ultimate goal is to describe evolution of metal alloy films, of particular relevance due to the possibility of forming multi-component nanoparticles. In this presentation we will present preliminary results on pattern formation that emerges in single-metal films under laser heating.

Dibakar Datta

Assistant Professor of Mechanical and Industrial Engineering

Two-dimensional (2D) materials and their heterostructures (2D + nD, n = 0,1,2,3) attracted enormous interest in many applications including batteries. Electro-chemo-mechanics plays a crucial role in designing these systems. 2D materials are engineered as the van der Waals (vdW) "slippery" interface. For example, silicon (Si) electrodes can be placed over the graphene-coated current collector for Lithium-Ion Batteries (LIBs). This arrangement provides less stress build-up and less stress "cycling" on the vdW slippery substrate instead of a fixed interface. DFT studies show stable performance and higher Coulombic efficiency for Si films deposited on graphene-coated nickel (i.e., slippery interface) than conventional nickel current collectors. Furthermore, interface strength variation between a-Si and Ti3C2Tx MXenes are determined for surface functional groups (Tx). The talk also summarizes our recent efforts in developing High Dimensional Deep Learning Potential (HDDLP) to study interfacial electro-chemo-mechanics in 2D materials-based systems. Our computational results are in good agreement with experiments.

Haim Grebel
Professor of Electrical and Computer Engineering

The global Electromagnetic Interference (EMI) shielding market is projected to grow at a Compound Annual Growth Rate (CAGR) of 4.4% - from $6.2 billion in 2021 and reach $7.7 billion by 2026. The growth of the EMI shielding market is mainly driven by increased demand for consumer electronics, EM pollution by various electrical sources, and the emergence of electric cars that produce (and being affected by) EMI and electromagnetic radiation. Conductive films and paints, or dispersed metal whiskers in a polymeric matrix are prevalent mitigation techniques. However, when car manufacturers seek lighter materials, such as carbon-enforced polymers, a metal hood is no longer an option. Here we propose a novel EMI shielding in a form of thin metal structures that can be incorporated into, e.g., smart buildings or modern cars. Graphite wires were found to be highly suitable for blocking microwave frequencies if structured properly.

Elektra Kostopoulou
University Lecturer of Federated History

This project aims to combine digital technologies and oral history in documenting the process of urban change in Newark, N.J. with a specific focus on migration from Southeast Europe and the Middle East. We argue that the project's specific scope offers a unique opportunity to increase the university's visibility and public engagement, while enhancing students' learning with novel interdisciplinary teaching and research methods. From the industrial boom of the late 1800s to the present, migratory movements from the above-mentioned regions have contributed significantly to the production of Newark's transnational demographic profile and urban footprint. Their historical visibility, however, remains limited. We believe that revealing these stories by creating a digital record can help our university build strong bridges with local communities. Moreover, we propose to actively engage students in this process via an innovative pilot course that will enable students to learn through hands-on engagement with Newark's migrant geographies: human, spatial, economic, and cultural.

Ioannis Koutis
Associate Professor of Computer Science

Ensemble learning is commonly viewed as a class of methods for improving the performance of machine learning algorithms. In human societies though, ensemble learning arises naturally due to the fact that single individuals do not have the capacity, under natural time constraints, to absorb the entire body of learnable knowledge. Humans not only learn as ensembles, but they also learn in peer groups that are also necessitated by resource constraints; teachers are relatively scarce and they have a bounded individual teaching capacity and different levels of expertise. Inspired by this by this analogy, we initiate a study of resource-constrained ensemble learning. We formulate the problem along with appropriate metrics of performance, and introduce a solution based on peer learning mechanisms where partially trained ensemble participants act as teachers to other participants. Furthermore, we hypothesize that grouping policies i.e. policies for matching teacher models with learner models) can play a significant role in the overall learning outcome of the ensemble. Through extensive experiments with different types of classifiers and datasets, we demonstrate that: (i)~An ensemble can reach surprising levels of performance even with little interaction with the training set. (ii)~Grouping policies have a clear impact on the ensemble performance, in agreement with previous intuition and observations in human peer learning. (iii)~Generalization takes place even in what we call the Planted Oracle Mechanism (POM), a setting of independent interest, where learners interact in random uncoordinated ways and the true labels are not explicitly revealed to the ensemble but are concealed as an ensemble participant. (iv) The POM learns a classifier with good generalization performance, but no capacity for "memorization."

Joseph Micale

Assistant Professor of Accounting

The relevance of Environmental, Social and Governance (ESG) activities has become increasingly prominent in accounting and finance. However, current databases providing information around ESG issues have received severe criticism for discrepancies, inconsistencies, lack of coverage, and biased reporting. This research plans to address this data problem by taking advantage of recent opportunities for data collection, interpretation, and classification based on firms' large-scale voluntary adoption of a unified set of sustainability reporting standards per the Sustainability Accounting Standards Board (SASB). The objective of this research project is to download, convert, and analyze ESG Sustainability Reports using textual analysis and machine learning techniques to obtain sentiment scores, qualitative vs. quantitative information, content classification, and topic modeling.

Amir K. Miri

Assistant Professor of Biomedical Engineering

The success of tumors-on-chips depends on the collection of cell bioparticles encapsulated in an extracellular matrix (ECM)-like system. Conventional collections of cell bioparticles require harvesting and digestion of ECM that suffer from undesired regulation of cellular behavior by the digestion process and hamper our ability to efficiently monitor the tumor cells. As a label-free, contactless, biocompatible, and high-throughput approach, acoustofluidic separation of bioparticles can be used in cell-laden hydrogels to enhance the rapid screening of tumor cells and other cellular components. We design and fabricate a novel 3D printed cell-laden hydrogel microfluidic platform equipped with an interdigital transducer surface acoustic wave module while controlling and tabulating the pore size/connectivity in the ECM-like hydrogel.

Jim Shi

Associate Professor of Finance

Commercial Real Estate (CRE), on one hand, ought to run on a purely business basis, driven by profit. On the other hand, being part of society, their decision process is always impacted by social and environmental issues, either directly or indirectly. In this project, we concentrate on the management of Distributed Energy Resources (DERs). DERs are complex power resources that need to be balanced for the grid to optimally function; diesel and nuclear generators, solar farms, fuel cells, wind mills on one hand and energy storage and flexible loads on the other. Locally assembled, they are considered as part of a micro-grid. This project leverages financial technology models (FinTech) in the business decision-making when balancing regulatory and power aspects in CRE. This approach could achieve a holistic risk assessment and management paradigm of grid's assets and will help maintain a supply-demand balance and system reliability, stability and efficiency of power resources.

Frank Shih
Professor of Computer Science

Over the past decades, the illicit drug market has been reshaped by the proliferation of clandestinely produced designer drugs. Synthetic drugs are increasing in popularity in the United States, who are acting to ban certain substances found in the drugs. However, new drug derivatives appear on the illicit drug market, making it difficult for legislation to keep up. Many synthetic drugs are very dangerous, and the overdose amount is in few milligrams, thus both identification and quantification of new drugs are very critical. In this project, we propose to develop deep learning techniques to automatically identify synthetic drugs. Our method employs a deep generative model to learn a statistical probability distribution over unobserved structure. The generation and incorporation of big data, through technologies such as high-throughput screening and high through-put computational analysis of datasets will increase the reliability of the deep learning incorporated techniques.

Daphne Soares
Associate Professor of Biology

One of the most shocking features of the human experience is the ubiquity of maladaptive behavior. There are multiple examples in Psychology, such as the propensity of self-harm, and Neurology, such as the phantom limb pain syndrome. Theoretically, evolution should have selected against these attributes in our ancestors, thousands of years ago. Yet, one in five of U.S. adults receive some kind of mental health treatment every year (CDC). This project addresses the conundrum of the permanence of maladaptation in neural circuits that create behavior. We study the Mauthner cell, a large and identifiable neuron in a hindbrain circuit that is vital for the survival of fishes. We have already shown that there are maladaptive features in the Mauthner cells of our fish model (Astyanax mexicanus: Tanvir., 2021). Our objective in this study is to take those results further and determine the molecular mechanisms responsible for Mauthner cell maladaptations. We designed experiments in Astyanax that address this permanence in two different time scales: one developmental and one evolutionary. This animal model is especially suited for our studies because it exists in two forms: one ancestral that lives in the rivers of central Mexico (surface fish), and various independently adapted new populations that live in caves of the mountain of Sierra del Abra (cavefish). These two forms are very different, but nevertheless are so close in evolutionary time that we can still interbreed them with viable offspring, making them an ideal model to pursue the molecular pathways that control both development and evolution.

Jongsang Son
Assistant Professor of Biomedical Engineering

Exoskeleton-assisted gait training has emerged as a promising approach in walking rehabilitation. However, the majority of the current exoskeleton control algorithms are not fully optimized to provide appropriate assistance. This deficiency leads to a strong need for a more effective assistance strategy. Thus, the main goal of this collaborative project is to develop a real-time muscle-tendon dynamics model for accurate estimation of muscle force and joint torque, as a critical input for devising optimal exoskeleton control strategies, along with ultrasound imaging and electromyogram technologies. This model will then be applied not only to design the exoskeleton control algorithms but also to evaluate the performance of the control algorithms based on muscle energetic analysis. The developed framework will allow us to quantify the effects of different assistance on different aspects of muscle energetics. The outcomes of this project will serve as preliminary results for future proposals on exoskeleton rehabilitation research.

Jinghua Wang

Assistant Professor of Finance

We investigate the predictabilities of the thirteen economic policy related uncertainty indices derived from the various measures on Bitcoin returns using machine learning algorithms. Based on the analysis on uncertainty indices, we find that Singapore economic policy uncertainty (SEPU) impact the most on Bitcoin returns. Financial crises uncertainty and world trade uncertainty are important features following SEPU. The empirical results reveal an interesting finding that the predictabilities of uncertainty indices derived from the international trade related category is stronger than other categories in the study. We also find that the impact from the internet-based uncertainty is stronger than the uncertainty indices derived from the newspaper-based and reports-based measures on BTC returns. The results are tested by the various machine learning methods.

Xianqin Wang

Professor of Chemical and Materials Engineering

Lithium-air batteries surpass lithium-ion batteries in energy density by a factor of two to ten. However, due to the kinetic of oxygen chemisorption, the cathode oxygen reduction and oxygen evolution reactions are sluggish in Li-air batteries. In this project, we use an N8 chain (PN) as a bifunctional nonmetallic catalyst for both of these processes. Preliminary results from density functional theory (DFT) calculations predict its performance, which rivals that of platinum in Li-air batteries. PN is environmentally-friendly, practical to synthesize, and inexpensive. However, no experimental data has been obtained to support this theoretical prediction. With this seed money, we are obtaining critical experimental data. This work involves novel material synthesis for powerful and long-lasting batteries, which fits into both Environment and Sustainability and Materials Science and Engineering clusters within the NJIT's strategic research plan.

Genoa Warner

Assistant Professor of Informatics

Nanoplastics are formed in the environment by weathering of plastic pollution in landfills and oceans. As a result, humans are widely exposed through food, air, and water. Although plastic particles have been identified in human tissues, little is known about the health impacts of nanoplastics. In addition, nanoplastics leach organic contaminants that may act synergistically to increase particle penetration and toxicity. This study will provide important toxicological evidence on the distribution of nanoplastic particles in tissues distant from the site of exposure using a human-relevant mouse model of early development. We will utilize the state-of-the-art analytical instruments in the York Center to: 1) track the pharmacokinetics of fluorescent nanoplastic particles in mice exposed to an innovative mixture of nanoplastics and organic contaminants and 2) characterize the size, shape, and surface functionality of nanoplastic particles to provide information on mechanisms of uptake and structure-toxicity relationships.

Hua Wei

Associate Professor of Computer Science

Multi-agent reinforcement learning (MARL), the extension of reinforcement learning (RL) methods for multi-agent domains, has gained popularity for generating high-quality solutions in some domains, such as autonomous racing vehicles and multi-robot control. Coming with popularity is the security issue caused by adversarial attacks, where an adversary can cause a well-trained agent to behave abnormally by tampering with the input to the agent's policy network or training an adversarial agent to exploit the victim's weakness. Existing works in adversarial learning on RL have several drawbacks: (1) practical attacks are not available since they implicitly assume an attacker has full control to influence an agent's sensory system; (2) none of the multi-agent studies managed to explore environments that have more than two agents. Therefore, the project will develop a number of novel methods to ensure the robustness of RL by exploring adversarial attacks and training antagonistic agents for competitive MARL.

Tomer Weiss

Assistant Professor of Informatics

Controlling the motion of agents with Reinforcement Learning (RL) is an area of continuing interest in multiple research communities. In this work, we focus on simulating the dynamics of multiple virtually embodied disc-like agents moving in a multi-agent environment. Recent trends include approaches for controlling agent navigation and maintain collision-free state, albeit without smooth-like control, which results in highly erratic and sudden navigational actions. However, smoothness in navigation decisions is an important factor when considering mechanical limitations, observer anticipation among other practical considerations. Our work focuses on navigational decision making via via two points: First, a reward function that rewards agents to behave in a real-crowd manner, and second, a position-based multi-agent dynamics framework for improved training and simulation stability. Furthermore, we demonstrate our method on several classical multi-agent benchmark scenarios, which show that our method significantly improves both qualitative and quantitative crowd multi-agent behavior.

Sara C. Zapico

Assistant Professor of Chemistry and Environmental Science

Predictive Models for Postmortem Interval Estimation (PMI): The correct determination of the PMI, the time elapsed between the physiological death of an organism and its examination, is crucial to elucidate the timing and sequence of events in criminal investigations. However, the majority of the current techniques to estimate PMI, like rigor mortis, only provide rough estimates. Current trends are looking for increasing the accuracy of PMI estimates based on quantifiable parameters. "Thanatobiology" refers to the techniques based on molecular biology approaches. Other techniques are based on the analysis of microbial communities through the corpse, named "thanatomicrobiome." This project combines, for the first time, these two methodologies, thanatobiology and thanatomicrobiome, leading, with the aid of machine learning approaches, to develop accurate prediction models for PMI estimation. Thus, this project aims to address one of the fundamental problems in forensic science from an interdisciplinary perspective, applying cutting-edge techniques, Next Generation Sequencing (NGS) technologies and machine learning.

Lijie Zhang

Assistant Professor of Chemistry and Environmental Science

Freshwater ecosystem provides important services such as food production, water supply, nutrient transport, and recreational value. However, climate change is transforming aquatic ecosystems. One of important yet unexplored climate-driven perturbations is the influences of cyanobacterial harmful algal blooms (cyanoHABs) on aquatic cycling of mercury (Hg) and subsequent impacts on human health. We therefore propose to conduct: (1) field investigations of the changes in biogeochemical conditions and Hg remobilization during different periods of cyanoHABs development in cyanoHAB-afflicted lakes; (2) microcosm experiments to assess long-term impacts of cyanoHABs biomass on the remobilization and transformation of Hg in aquatic environments; and (3) laboratory studies of the pathways and mechanisms of cyanoHABs biomass-Hg interactions. This project will generate new perspectives concerning the remobilization, transformation, and bioaccumulation of Hg species in freshwater environments during cyanoHABs. Research outcomes will help improve management and assessment of the combined risks of cyanoHABs and Hg to wildlife and humans.

Notes

NJIT
New Jersey Institute
of Technology

University Heights
Newark, NJ 07102

njit.edu/research

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