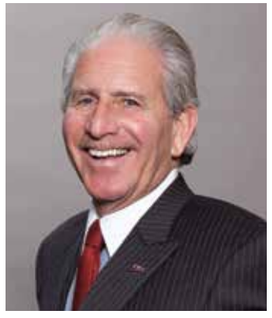
NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Monday, March 26, 2018

NJIT
New Jersey Institute of Technology

The President's Forum



New Jersey Institute of Technology, as one of only 32 polytechnic universities in the United States, fills a critical role in a world that is being driven by technological innovation. NJIT educates a highly diverse and exceptionally accomplished student body, preparing them to become the science, technology, engineering and math (STEM) workforce that is needed across all industries. NJIT also serves as a catalyst for research that solves major challenges, improves quality of life and leads to economic growth. Our university expends approximately $140 million annually on research activity and generates a yearly economic impact of more than $1.74 billion on the State of New Jersey. We host the President's Forum and Faculty Research Showcase each year to highlight various research initiatives and stimulate collaboration around significant opportunities for future exploration.

As part of the Albert Dorman Honors College Colloquium Series and through the generous support of the DeCaprio Family, the President's Forum provides for the NJIT community a unique opportunity for learning and discussion. Our keynote speaker for this spring's President's Forum is Dr. Wendy Nilsen, whose lecture is entitled "Solving Wicked Problems with Science." Wendy is a program director for the Smart and Connected Health Program in the Directorate for Computer & Information Science & Engineering at the National Science Foundation. Her work focuses on the intersection of technology and health, including methods for data collection, advanced analytics and the creation of effective cyber-human systems. Her interests span the areas of sensing, analytics, cyber-physical systems, information systems, big data and robotics.

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 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, the National Institutes of Health and 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 relevance of their work to improving our world and our lives.

Joel S. Bloom
President of NJIT

NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Transforming the Research Enterprise at NJIT

Over the past four decades, NJIT has evolved from a commuter school teaching applied engineering skills into a nationally ranked public research university. This has been a remarkable transformation. In 1979, our research expenditures totaled $375,000; today they surpass $140 million. As our research profile grew, so did our capacity as an educational institution. NJIT has been awarding doctoral degrees for more than 50 years; we have recently awarded more than 60 in 19 different disciplines during a single year. In short, the university has grown from its roots as a local college focused on teaching into a residential and highly selective research institution.

Developing knowledge and applying it to the benefit of society requires talent, substance and resources. We are actively recruiting, developing, supporting and retaining an exceptional faculty, providing the environment necessary for success from the moment of their appointment to the peak of our scholars' academic careers. We also aim to break down barriers to multidisciplinary collaborations as contemporary research demands it. We value entrepreneurial research, promote our inventions and facilitate technology transfer.

Now, NJIT is embarking on a far-reaching plan to transform our research enterprise again, elevating the university to a top-tier institution conducting groundbreaking research in many fields. We aim for prominence. Nowhere are these changes more apparent than in our people. Over the past six years, NJIT has brought nearly 110 new faculty members to campus as we deepen our capabilities across STEM and other disciplines. As part of the university's strategic plan, *2020 Vision*, we are beginning a multiyear hiring effort that will grow our faculty even further, from 269 in 2014 to 345 by 2020. 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.

So it is with enormous pride that NJIT showcases its growing research talent in the Fifth Faculty Research Symposium. Some of the presentations you will hear today represent interdisciplinary collaborations brought to life on campus with seed funding from a new research program designed to tackle problems in fields such as the life sciences and health care, sustainable systems, and data science that represent the university's core strengths. They bridge disciplines as distinct as architecture and computer science. As we create new academic hubs on campus, we hope to inspire many more productive partnerships. We have nearly doubled research funding from external sources since the 2014 baseline of *2020 Vision*.

We will also measure the impact of our ambitious transformation from multiple perspectives. Critically, we will assess our success in materially improving lives both in our immediate region and in communities across the globe that benefit from the technology we develop and effectively deploy. Just as importantly, we will judge our achievement by the number of technology innovators we nurture in our undergraduate and graduate programs, exposing them to high-level research and real-world applications, so they are empowered to confidently take on the problems of tomorrow.

Fadi P. Deek
Provost and Senior Executive Vice President

Program

Campus Center, Ballrooms A and B
10 a.m. - 10:15 a.m.

Welcome

Joel S. Bloom
President of NJIT

Vincent L. DeCaprio '72
Vice Chair, NJIT Board of Trustees

Fadi Deek
Provost and Senior Executive Vice President

10:15 a.m. - 10:20 a.m. **Speaker Introduction**
Atam Dhawan
Senior Vice Provost for Research

10:20 a.m. - 11:30 a.m. **President's Forum: Keynote Lecture**
Dr. Wendy Nilsen
Program Director for the Smart and Connected Health Program
Directorate for Computer & Information Science & Engineering
National Science Foundation

11:30 a.m. - 12:30 p.m. **Lunch and Networking**

12:30 p.m. - 2 p.m. **New Faculty Presentations**

2 p.m. - 3 p.m. **Poster Presentations and Networking Session:**
New Faculty and Faculty Seed Grant Recipients

This President's Forum is a featured event
in the Albert Dorman Honors College Colloquium Series
and is made possible in part
by the generous support of the DeCaprio Family.

NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Keynote Speaker

Wendy Nilsen, Ph.D.

Program Director for the Smart and Connected Health Program
Directorate for Computer & Information Science & Engineering
National Science Foundation

Wendy Nilsen, Ph.D., is a program director for the Smart and Connected Health Program in the Directorate for Computer & Information Science & Engineering at the National Science Foundation. Her work focuses on the intersection of technology and health, covering a wide range of methods for data collection, advanced analytics and the creation of effective cyber-human systems.

Her interests span the areas of sensing, analytics, cyber-physical systems, information systems, big data and robotics. More specifically, her efforts include: serving as co-chair of the Health Information Technology Research and Development working group of the Networking and Information Technology Research and Development Program; serving as the lead for the National Science Foundation/National Institutes of Health Smart and Connected Health announcement; convening workshops to address methodology in technology in health research; serving on numerous federal technology initiatives; and, leading training institutes. Prior to joining the National Science Foundation, Wendy worked for the National Institutes of Health.

Keynote Lecture: Solving Wicked Problems with Science

Science is changing rapidly and new transdisciplinary approaches are resulting in transformative change across domains. Complex issues, such as in healthcare, have begun to be addressed with convergent approaches that involve expertise from a range of diverse disciplines. This has resulted in new methods and findings that could not have happened a decade earlier. Computing, information science, informatics and engineering are especially poised to contribute to these changes by bringing sophisticated techniques to partnerships in the biomedical and bio-behavioral realms. This talk will cover some current advances and a vision for a smarter community, using the area of health and medicine as an example.

Faculty Research Presentations

College of Science and Liberal Arts

Phillip Barden
Assistant Professor of Biological Sciences

Phillip Barden joined NJIT following a National Science Foundation Postdoctoral Research Fellowship in Biology at Rutgers University-Newark. His research program, which is rooted in evolutionary biology, focuses on social insects and blends elements of paleontology, bioinformatics, and X-ray imaging. He has developed imaging pipelines from CT-scanning amber fossils to 3D modeling in an effort to reconstruct species that have been extinct for approximately 100 million years, or 35 million years before the end of the age of dinosaurs. In so doing, he has utilized equipment ranging from desktop-sized X-ray sources to the one kilometer-long United States Department of Energy (DOE) Advanced Photon Source at Argonne National Laboratory. Dr. Barden's paleontological work relates to the description and interpretation of the earliest known fossil evidence for social behavior in ants and termites. With respect to genetic data, he is working to identify convergent trends or "rules" related to sociality, and the genomic foundations and consequences of highly social behavior. His research has taken him on fossil digs within Indian strip mines, to the primary rainforest of Borneo to study modern ants, and aboard the ferry to Staten Island to explore fauna closer to home.

Title: Paleontology and Comparative Genomics as Windows into Evolutionary History and Social Behavior

From biology textbooks to the ubiquity of social insects in terrestrial ecosystems worldwide, eusociality is a profound emergent phenomenon. Over the last 100 million years, highly social insects such as ants and termites have reshaped our planet. We are unraveling the evolutionary history of these highly successful lineages while working to understand the genetic foundations of sociality. Fossil amber facilitates this process as a direct window into ancient organisms and ecosystems. Through high resolution X-ray imaging, we are reconstructing long-lost species and detailing patterns of extinction. At the same time, by comparing the genomes of living species across independent evolutionary origins of social behavior, our goal is to reveal universal genetic trends that underpin sociality.

Christina Frederick
Assistant Professor of Mathematical Sciences

Christina Frederick comes to NJIT from the Georgia Institute of Technology, where she was a National Science Foundation Interdisciplinary Mathematics Preparation and Career Training (IMPACT) Fellow in the School of Mathematics since 2015. She has a Ph.D. in mathematics from the University of Texas at Austin. Her primary research interests lie in the area of inverse problems for partial differential equations, specifically in the development of new techniques for determining coefficients in the equations from solution data by finding ways to exploit underlying multiscale structures.

Title: Optimal Transport Strategies for Multi-Robot Path Planning

The benefits of multi-robot systems, as opposed to single-robot systems, include better spatial distribution, efficiency and robustness at completing a task due to division of labor and reliability. If the robots have low functionality, for example, limited communication or a fixed sensing range, they may be manufactured at a much lower cost than sophisticated single-robot systems. In this work, we establish a simple, effective strategy for enabling a group of low-functioning robots to accomplish complex tasks with an intelligent control process. The design of the strategy is inspired by the theory of optimal transport, which has been rapidly developing in the last two decades and has been applied to problems in optics, astronomy and seismic imaging. This theory allows us to describe the dynamics of multi-robot shape formation using a system of stochastic differential equations (SDEs). By analyzing the SDEs that drive the robot trajectories, we provide rigorous guarantees of collision avoidance and convergence of the system.

NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Elizabeth Nowadnick
Assistant Professor of Physics

Elizabeth Nowadnick joined NJIT from Cornell University, where she was a postdoctoral research associate in the School of Applied and Engineering Physics. She obtained both her B.S. in physics and mathematics and her Ph.D. in physics from Stanford University. Her research uses a combination of quantum mechanical simulations and theoretical approaches to advance our fundamental understanding of the properties and functionality of complex oxides and other quantum materials. Her research has been published in leading journals such as Physical Review Letters, Nature Materials and Nature Physics.

Title: Harnessing Structural Complexity to Engineer New Multifunctional Oxides

Complex oxides exhibit an incredible diversity of properties ranging from ferroelectricity and ferromagnetism to unconventional superconductivity. In addition, they are promising candidates for applications ranging from data storage to battery technology. Controlling the interplay between the microscopic electronic, spin and orbital degrees of freedom in these structurally complex materials is a central challenge. In this talk, I will show how advanced quantum mechanical, computational and theoretical techniques can meet this challenge and enable the understanding, design and discovery of novel multifunctional materials with targeted properties. As an example, I will discuss new insights into a recently discovered type of ferroelectric oxide, which may enable electric field control of magnetic, orbital and electronic states.

Anand U. Oza
Assistant Professor of Mathematical Sciences

Anand Oza joined NJIT from the Courant Institute, where he was a National Science Foundation Mathematical Sciences Postdoctoral Fellow. He received his Ph.D. in 2014 from MIT, where he was supported by a Hertz Foundation Graduate Fellowship. Oza is a theorist interested in fluid mechanics and nonlinear dynamics, specifically with applications in soft matter physics and biological systems. He has recently focused on hydrodynamic interactions in "active systems," in which collections of objects both generate and interact with fluid flows. His research utilizes a combination of analytical techniques and numerical simulations, and is typically conducted in collaboration with experimentalists.

Title: Wave-Particle Coupling in Active Systems

There has recently been a surge of interest in the field of "active matter," which comprises systems that are driven out of equilibrium by internal or external energy input. While there has been significant progress in understanding dry active systems, such as shaken granular materials, much less is known about active particles that are coupled through waves in a fluid. I will outline my recent work on two such systems: oil droplets bouncing on a vibrating fluid bath and freely-moving flapping swimmers in a water tank. Both systems are motivated by recent experiments, and our theories are used to both interpret experimental observations and predict new phenomena.

Rebekah Rutkoff

Assistant Professor of Humanities

Rebekah Rutkoff joined NJIT from Princeton University, where she was a Princeton Arts Fellow. Her research explores the crossroads of cinema studies, theories of magic and ancient and contemporary discourses about dreaming and cure. She is currently writing about the American avant-garde filmmakers Robert Beavers and Gregory Markopoulos. She is the author of The Irresponsible Magician: Essays and Fictions (semiotext(e), 2015) and the editor of Robert Beavers (Austrian Film Museum, 2017), a book of essays by and about the American filmmaker. She is a former member of the Institute for Advanced Study, Princeton, and the recipient of a Creative Capital/Warhol Foundation Arts Writers Grant for her work on the pioneering computer artist Lillian Schwartz.

Title: Theorizing Experimental Media

Rutkoff, who works at the intersection of film studies, psychoanalysis and philosophy, is currently completing The Importance of Seeing Shapes, the first single-author monograph on the American avant-garde filmmaker Robert Beavers. Other projects include Cinematic Incubation, on the filmmaker Gregory Markopoulos' site-specific work of expanded cinema in Arcadia, Greece, known as the Temenos, and Sylvia & Geza, a study of the roles and uses of abstract painting in psychoanalytic theory. Her work on the pioneering artist Lillian Schwartz, who produced key works of early computer art at Bell Labs, is part of a larger research project on moving image experiments by American women.

Kristen E. Severi

Assistant Professor of Biological Sciences

Kristen Severi came to NJIT from the Institut du Cerveau et de la Moelle Epiniere (ICM, Brain and Spine Institute) and the Laboratoire Jean Perrin at Universite Pierre et Marie Curie, where she has been a postdoctoral fellow since 2012. She has a Ph.D. from Northeastern University, where she forged a collaborative project between Northeastern and Harvard University. Her research area is the study of the neural circuits which underlie motor behavior in the zebrafish model. Zebrafish have become a top model system in neuroscience over the past 10 years due to their genetic tractability and optical transparency for whole-brain functional imaging. She has expertise in cutting-edge biological imaging techniques such as two-photon laser scanning and light-sheet volumetric imaging, which are ideally matched for viewing the activity of the live zebrafish brain while it performs locomotor tasks.

Title: Understanding Locomotor Circuits in the Larval Zebrafish

The neural circuits for locomotion are located in the brain and spinal cord of vertebrate animals, and we use them every day to get from place to place. We know how important these structures are because injury or disease results in paralysis. To understand how the neurons which perform locomotion function in real time, Severi uses the larval zebrafish as a model because it has a simple and transparent nervous system. This allows us to visualize neural activity in real time as animals perform motor tasks to decode how these circuits function in intact animals.

NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Newark College of Engineering

Pramod Abichandani

Assistant Professor of Engineering Technology

Pramod Abichandani's research interests are centered around optimal, multi-dimensional, data-driven decision-making, through the use of techniques from mathematical programming, linear and nonlinear systems theory, statistics and machine learning. Areas of research include optimal control of robotics systems, data-driven decision-making using probability models, embedded systems design for data acquisition and control and online engineering education.

Title: Communication-Centric Outdoor Navigation and Formation Control for Multi-Drone Systems

The objective of this research is to lay the foundations of designing, developing and evaluating a communication-centric unmanned multi-quadcopter platform for outdoor navigation and formation control. The platform is being used to demonstrate novel decentralized multi-drone navigation research results. As outdoor drone navigation algorithms and associated numerical solvers continue to develop, we anticipate that this platform will be used to evaluate to an increasing number of multi-drone problems and that this research effort may serve as a guide for future outdoor multi-drone research.

Esra Büyüktahtakun

Associate Professor of Mechanical and Industrial Engineering

Esra Büyüktahtakın joined NJIT from Wichita State University (WSU), where she was an associate professor in the Department of Industrial, Systems, and Manufacturing Engineering. Her research involves developing mathematical optimization models and algorithms to tackle sustainability and healthcare problems, such as pests that create havoc on forests and diseases that ravage the human body. With the results from her research, policymakers can make better decisions about where and when to allocate limited resources to battle biological invasions. She also uses her modeling research in the area of human diseases, such as designing optimal chemotherapy planning strategies for patients with breast cancer and optimal management of infectious diseases, such as Ebola and the human immunodeficiency virus.

Title: A New Modeling Framework for Controlling Epidemics: Insights into Controlling the Ebola Virus Disease in West Africa

In this talk, I will focus on intervening in an epidemic outbreak, specifically introducing a new mathematical optimization model that dynamically determines the optimal number and location of treatment centers and allocates treatment resources for controlling an epidemic outbreak while accounting for its spatial spread dynamics. The objective of this proposed model is to minimize the total number of infections and fatalities due to an epidemic under scarce intervention resources over multiple periods. The present study is the first spatially explicit optimization approach that considers geographically varying rates for disease transmission, migration of infected individuals over different regions and varying treatment rates due to the limited capacity of treatment centers. I will present the performance of the model using the case of the 2014–2015 Ebola epidemic outbreak in Guinea, Liberia and Sierra Leone. The proposed modeling framework can be adopted to study other infectious diseases and provide tangible policy recommendations for controlling an infectious disease outbreak over large spatial and temporal scales.

Huiran Jin

Assistant Professor of Engineering Technology

Huiran Jin came to NJIT from the University of Maryland, where she was a postdoctoral research associate in the Department of Geographical Sciences. Her research has focused on the advancement of geospatial analysis and modeling applications for the optimization of remote sensing endeavors, such as land cover and land use mapping, wetland inundation monitoring, urban growth detection and crop growth modeling and yield estimation. In the past few years, Jin has worked on decision-support algorithm development and large-volume spatio-temporal data analysis.

Title: Monitoring of Land Cover/Land Use Using Multi-Type Remotely Sensed Data

Land cover and land use (LCLU) are fundamental attributes that link physical environments and human activities. Timely and accurate information on LCLU and LCLU change is an indispensable data component for a broad range of environmental and socioeconomic studies. In recent decades, remote sensing has been recognized as a major source of LCLU information, especially for large areas, including over a long time period. The primary goal of my research is to investigate viable methods for improving the accuracy of LCLU products derived from multi-type spectral, SAR and LiDAR data. In this talk, I will present some of my recent work on flood mapping, wetland inundation monitoring, urban growth detection and crop yield estimation using remotely sensed data and spatio-temporal analysis. Factors that impact the quality of remote sensing-derived products will also be briefly discussed.

Simone Marras

Assistant Professor of Mechanical and Industrial Engineering

Simone Marras joined NJIT from Stanford University, where he was a research scientist in the Department of Geophysics. He received an M.S. in aerospace engineering from Politecnico di Milano in Italy and a Ph.D. from the Universitat Politècnica de Catalunya jointly with the Barcelona Supercomputing Center in Spain. After receiving his doctorate, he spent two years at the Department of Applied Mathematics at the Naval Postgraduate School as a National Research Council Research Associate (NRC of the National Academies of Sciences, Engineering, and Medicine). During the past ten years, Dr. Marras spent extended visits at UCLA, Cambridge University, the Naval Postgraduate School and the University of Texas at Austin. His research interests include computational fluid dynamics for compressible flows, large eddy simulation of turbulence and aeroacoustics.

Title: Towards a Quiet (Clean) Energy

According to Executive Order 13693 of the President of the United States (2015), by 2025, 30 percent of the electricity consumed by the federal government should come from renewable sources. Within the framework of renewables, wind energy occupies the largest volume. It is within this context, and with the under-explored science of wind acoustics in mind, that I am aiming for the development of efficient and accurate numerical algorithms for the high-fidelity solution of the equations of aerodynamic noise. The outcome of this research shall allow engineers the ability to design large-scale wind farms of lower acoustic pollution than anything in existence today.

NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Kathleen McEnnis

Assistant Professor of Chemical and Materials Engineering

Prior to joining NJIT, McEnnis was a postdoctoral fellow at the University of Michigan, working with Professor Joerg Lahann in the Chemical Engineering Department on multi-compartmental particles for drug delivery. She completed her Ph.D. in polymer science and engineering from the University of Massachusetts at Amherst under the guidance of Professor Thomas Russell, and also received a B.S. from MIT in Chemistry where she worked in Professor Paula Hammond's lab. Her current research involves investigating the interaction of polymer drug delivery vehicles with the biological environment (cells, blood, proteins and physiological temperature) using physical chemistry techniques in novel ways with the goal of designing better particles for drug delivery.

Title: Particle Analysis in Biological Environments

Drug delivery vehicles are an ideal treatment solution for many diseases. In practice, however, designing successful drug delivery vehicles is challenging, and there are very few instances of drug delivery vehicles currently used clinically. The interaction of the biological environment with drug delivery vehicles is not well understood, and by addressing this gap, better and more successful drug delivery vehicles can be designed. My lab investigates the interaction of drug delivery vehicles with the biological environment using characterization techniques in novel ways to design particles for drug delivery. This talk will present a brief overview of some of the methods we use to analyze particles in the biological environment.

Lucia Rodriguez-Freire

Assistant Professor of Civil and Environmental Engineering

Lucia Rodriguez-Freire joined NJIT from the University of New Mexico, where she was a postdoctoral research fellow in the Department of Civil and Environmental Engineering. As a postdoctoral researcher, she investigated the biogeochemical processes that affect the cycle of metals and radionuclides in the environment. Prior to her last appointment, she was a postdoctoral researcher at the University of Arizona, where she developed a novel technique to degrade fluorinated compounds found in fire-fighting foams using sound to break down the molecules (sonochemical degradation). During her graduate work at the University of Arizona, Rodriguez-Freire worked to understand the factors controlling microbial arsenic transformations in the environment, and the potential for mineralization of arsenic as a bioremediation technique. Her new Laboratory of Applied Biogeochemistry for Environmental Sustainability investigates the mechanisms of interaction between biological and inorganic systems. The lab investigates these mechanisms to discover ways to remediate contaminated sites while recovering valuable materials using ubiquitous and low-value materials.

Title: Holistic Integration of Chemical and Biological Processes to Control the Fate of Contaminants in the Environment

Biogeochemical interactions play a key role in controlling the speciation and mobility of metals in the environment through direct metabolic processes such as metal uptake, biotransformation and biomineralization, or indirectly by changing ambient redox/pH conditions, producing ligands or new biominerals, or altering mineral surfaces. My research group's overarching objective is to understand and control the complex mechanisms of contaminant transformations in the environment. Our goal is to engineer remediation and resource recovery technologies, mimicking natural and sustainable processes. My talk will briefly describe current work on the phytoaccumulation of uranium in plant roots near an abandoned uranium mine, and the biogeochemical transformations controlling metal stability in river sediments after an acid mine drainage spill, as well as more recent research ideas for biomimetic design.

Martin Tuchman School of Management

Jorge E. Fresneda

Assistant Professor of Digital Marketing and Marketing Analytics

Jorge Fresneda joined NJIT from the LeBow College of Business at Drexel University, where he received a Ph.D. His research interests expand from the role of online information as influencing consumers, to the economic impact derived from the lack of accessibility of e-commerce sites for people with disabilities. An important part of his research deals with the application of methods to analyze unstructured online data (artificial intelligence, latent semantic analysis or topic models). Fresneda also works with companies to develop innovative data analysis methods focused on extracting information from readily available online sources. He regularly conducts workshops on automatic methods of text analysis. Fresneda has recently published a tutorial on the application of latent semantic analysis in social sciences.

Title: A Syntax Measure of Online Review Helpfulness and the Importance of Message Entropy

The helpfulness of online reviews and their impact on purchase decisions is well established. Much previous research measured that helpfulness through the automated vote-up/vote-down assessment icon that is available on many online sites that include online reviews. This study examines an alternative, complementary measure based on text analysis of the term "helpful" in those reviews. Analyzing over 20,000 reviews at Amazon.com shows that the new measure has a considerably higher R2 and that it is not affected by review order, avoiding this source of bias. In contrast, the current helpfulness measure is strongly impacted by posting order. The potential of this new measure of helpfulness is discussed.

Raja Roy

Assistant Professor of Innovation and Entrepreneurship

Raja Roy explores the role of firm-level capabilities, such as access to complementary technologies and in-house users, during technological change in high-tech industries. He is widely published in the field of disruptive change, including technological disruption in machine tools, industrial robotics and image sensors. He is currently exploring the evolution of space travel. He is also an award-winning teacher. In an earlier stint at Tulane University, he received the university's Outstanding Entrepreneurship Educator Award for teaching graduate-level entrepreneurship courses.

Title: When Dinosaurs Fly: The Role of Firm Capabilities in the 'Avianization' of Incumbents During Disruptive Technological Change

Prior research suggests that large incumbents will become victims of disruptive technological change. We investigate the image sensor industry in which the emergence of CMOS sensors challenged the manufacturers of CCD sensors. Although this disruptive technological change led to the demise of CCD technology, it also led to avianization – or strategic renewal – for some incumbents, similar to how some dinosaurs survived the mass Cretaceous-Tertiary extinction by evolving into birds. We find that CCD manufacturers that did avianize were preadapted to the disruptive CMOS technology in that they possessed relevant complementary technologies and access to in-house users that allowed them to strategically renew themselves.

NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Stephen Taylor

Assistant Professor of Finance

Stephen Taylor came to NJIT following seven years in the financial services industry as a quantitative research analyst, where his work encompassed a variety of quantitative projects, including developing hedging algorithms and implementing risk- and performance-metric monitoring software. In addition, Taylor was a technical staff member at MIT's Lincoln Laboratory, where he worked on developing radar compression algorithms. His interests reside at the intersection of the application of mathematics, statistics, finance, and data analysis and visualization.

Title: Equity Clustering Using the Fisher Information Metric

Information Geometry offers a correspondence between differential geometry and statistics through the Fisher Information matrix. In particular, given two models from the same parametric family of distributions, one can compute the distance between these models using only their parameters and the Fisher Information matrix for this family. One practical limitation of this distance is that it is often difficult to calculate. We review such complications and provide a general form for the distance function for one-parameter models. We next focus on higher dimensional extreme value models, including the Pareto distribution, and discuss how to use shooting point methods to solve the geodesic equation. Finally, we present an application where we first fit extreme value distributions using maximum likelihood estimation to all S&P 500 stocks and then compute the pairwise distances between their best-fit parameters. This is used as an input into a hierarchical clustering algorithm to provide a tail risk-based clustering of the securities.

Ying Wu College of Computing

Amy Hoover
Assistant Professor of Informatics

Amy K. Hoover came to NJIT from Northeastern University's Playable Innovative Technologies Lab, where she was a postdoctoral research fellow, and from the Institute of Digital Games at the University of Malta. Through the support of a National Science Foundation Graduate Research Fellowship, she earned her Ph.D. in computer science at the University of Central Florida, where she also earned an M.S. and B.S. in computer science and a B.S. in mathematics. Her research focuses on building systems to empower human-computer collaboration, particularly in games and other creative domains.

Title: Games, Creativity and AI
While traditionally associated with artists and musicians, creativity is increasingly valued by those in STEM fields wishing to push beyond the boundaries of today's technology. Perhaps because encouraging creativity is often challenging for educators and its outcomes are difficult to assess, students typically receive little support and encouragement. However, by building systems to support human and computer co-collaboration, my work aims to democratize the creative process by designing software that acts as a partner to help people realize their creative potential. Conceptualizing creativity as a search in a structured space of computational artifacts, I will discuss my work constructing a particular search space and method to help amateurs compose music, as well as design video game levels. Both of these projects are based on a method I developed called "functional scaffolding for music composition," and together, they demonstrate the potential for a single algorithmic method to support creativity and learning in multiple domains. I will then provide examples of similar methods I implemented to support algorithmic and computational thinking through video games.

Ioannis Koutis
Associate Professor of Computing Science

Ioannis Koutis joined NJIT from the University of Puerto Rico, Rio Piedras, where he was an associate professor. He received his Ph.D. in computer science from Carnegie Mellon University and his undergraduate diploma in computer engineering and informatics from the University of Patras in Greece. In the past, he has worked as a systems scientist at Carnegie Mellon University. He designs tools capable of probing large networks based on fast linear system solvers and other numerical algorithms. Additionally, his 'algebraic fingerprints' method enables the design of faster exact and parameterized algorithms for a multitude of challenging computational problems.

Title: Fast Linear System Solvers and Applications in Data Science
We present recent progress in the design of solvers for systems of linear equations. These solvers have led to fast algorithms that are used to probe very large networks and open the way to new applications in data science, as well as new theoretical discoveries.

NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Jing Li
Assistant Professor of Computer Science

Jing Li joined NJIT from Washington University in St. Louis, where she received her Ph.D. in 2017. Her research encompasses a broad area of parallel computing, real-time systems and cyber-physical systems. In particular, she focuses on exploiting the untapped efficiencies in multi-core computing platforms to improve the scalability and quality of service for applications in cyber-physical systems and interactive online cloud services, such as applications in autonomous vehicles, robotics, web searches and online gaming. She has developed theoretical foundations and practical platforms for executing parallel applications on multi-cores to improve their temporal performance. For example, she designed and implemented a parallel real-time platform, called a federated scheduling system, which is used by earthquake engineers to build hybrid-testing systems to study the structural properties of buildings.

Title: Parallel Real-Time Systems for Latency-Critical Applications
Real-time systems need to provide timing guarantees for latency-critical applications that interact with humans and/or the physical environment. Examples span from cyber-physical systems, such as autonomous vehicles, avionics systems and robotics, to interactive cloud services, such as web searches, stock trading and online gaming. However, as parallel machines are becoming ubiquitous, we face challenges in designing real-time systems that can fully utilize the efficiencies of parallel computing platforms. In this talk, I will present an example in which our parallel real-time system exploits the untapped efficiencies in the parallel platforms and drastically improves the system performance for a cyber-physical system.

David Shaohua Wang
Assistant Professor of Computer Science

David Shaohua Wang came to NJIT from Queen's University at Kingston, Ontario, where he was a postdoctoral research fellow in the Department of Electrical and Computer Engineering. He was a research student at IBM from 2012 to 2016, and has won an IBM Fellowship. His research concentrates on the intersection of software engineering and machine learning, with applications in smart and secure software systems that optimize users' interactions with software. His system for analyzing big user data automatically assists people in filling out web-based services, eliminating repetitive typing. His current "Smart Internet-of-Things" project is partially funded by Microsoft Azure Research Award. He held multiple software engineering positions in Toronto and has extensive working experience in web systems.

Title: Analyzing Massive Software Data to Build Intelligent Everyday Software
People are empowered to do amazing things using software, such as shopping online. Massive datasets having valuable knowledge (e.g., human choices) are generated every day. Learning to analyze such big data is critical in adding intelligence to everyday software. Therefore, the goal of my research is to build smart everyday software systems that can understand user needs by analyzing massive data through machine learning, natural language processing and big data techniques. In this talk, I present my prior research projects that tackle widespread and pervasive problems for improving the smartness and reliability of software systems. Last, the presentation touches my current research projects.

Faculty Seed Grant Recipients

Matthew Adams
Assistant Professor of Civil and Environmental Engineering

Title: Use of Ettringite Cement Systems for Long-Term Energy Storage Through Thermochemical Reactions
Typically, our energy systems have to be designed to cope with peak energy demand situations, resulting in costly, inefficient systems that waste energy during low demand periods. Meeting these demands requires long-term, energy efficient storage solutions that can hold energy over long time periods with minimal loss. The U.S. Department of Energy has noted the need for more revolutionary materials and solutions, for which cement chemistry offers a potential solution. Ettringite-based cements are a type of hydraulic binder that, when mixed with water, result in the hydration product known as ettringite (3CaO.Al2O3.3CaSO4.32H2O). Current research has shown that ettringite-based cement paste mixtures may be a viable tool for thermal energy storage through the dehydration and rehydration of the ettringite crystals. The goals of the research are to determine: the long-term stability and viability of ettringite based cement materials for thermal energy storage; and the potential energy efficiency of ettringite-based thermal storage systems. The results obtained from the experiments will help identify under which conditions the long-term reversibility and efficiency of the ettringite conversion is possible.

Pramod Abichandani
Assistant Professor of Engineering Technology

Title: Communication-Centric Outdoor Navigation and Formation Control for Multi-Drone Systems
The objective of this research is to lay the foundations for designing, developing and evaluating a communication-centric unmanned multi-quadcopter platform for outdoor navigation and formation control. The platform is being used to demonstrate novel decentralized multi-drone navigation research results. As outdoor drone-navigation algorithms and associated numerical solvers continue to develop, we anticipate that this platform will be used to evaluate an increasing number of multi-drone problems and that this research effort may serve as a guide for future outdoor multi-drone research.

Shahriar Afkhami
Associate Professor of Mathematical Sciences

Title: Spreading and Mixing of Alcohol Drops on Water
When a drop of alcohol is brought close to the water-air interface, variation in the surface tension of alcohol-air and water-air induces a surface flow, also known as Marangoni flows, manifested in the "Tears of Wine" phenomenon. To name a few applications, these flows on the surface of liquids can drive the flow in the bulk, generating an efficient mixing mechanism in microfluidic systems, or they can be used in surface cleaning without contamination. We carry out numerical simulations of spreading and mixing alcohol drops on water in coordination with available experimental observations. In particular, we compute the spreading velocity and provide detailed insight of the mixing of the drop and water. We investigate the details of the flow patterns generated in the bulk as an effect of the surface flows.

NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Lisa Axe
Chairperson and Professor of Chemical and Materials Engineering

Mengyan Li
Assistant Professor of Chemistry and Environmental Science

Title: Biologically Active Filtration System for Effective Removal of Emerging Water Contaminants
Our water safety is threatened by the plethora of organic contaminants with anthropogenic origin that are not yet regulated and are referred to as contaminants of emerging concern (CECs). CECs have been found throughout the water cycle, in wastewater treatment plant influents and effluents, surface water, and even in drinking water treatment and distribution systems. These CECs are comprised of pharmaceuticals, personal healthcare products, pesticides and steroids. Unfortunately, conventional water and wastewater treatments are marginally effective in removing CECs. A biologically active filtration (BAF) system synchronizing hydrophobic adsorption, ion exchange and accelerated biotransformation is one of the top effective and economical treatment synergies to remove CECs. The overarching aim of this project is to optimize the performance of BAF systems for CEC removal by integrating robust microbial seeding with novel adsorbent media and appropriate pre- and post-treatment technologies. Biomass-derived char materials with desired properties (e.g., enhanced anion exchange capacity and microbial adhesion) will be manufactured for BAF applications. Phylogenetic diversity and molecular mechanisms of the enriched dominant degraders will be uncovered using high-throughput metagenomic and metatranscriptomic techniques in conjunction with conventional isolation approaches.

Matthew Bandelt
Assistant Professor of Civil and Environmental Engineering

Title: Mitigating Infrastructure Deterioration with Ductile Cement-based Composites
Ductile cement-based composites are an emerging class of infrastructure materials that limit damage from mechanical and environmental conditioning in structures through the use of short randomly oriented fibers. This research program involves developing computational modeling tools to: understand how ductile cement-based materials resist deterioration mechanisms; predict long-term deterioration with emerging cementitious materials; and create new techniques to design ductile cement-based materials to limit deterioration of infrastructure. Computational models are being compared to experimental results to validate the numerical approach.

Cesar Bandera
Assistant Professor of Entrepreneurship

Title: Automated Assessment of Entrepreneurial Disposition
Stakeholders in economic development, including educators, corporate managers and ecosystem administrators, evaluate their constituents' disposition to entrepreneurship and intrapreneurship (E&I). However, the globalization and multidisciplinary nature of E&I requires assessment methods that are automated and sensitive to cultural disparities. Such methods do not currently exist but are made feasible by emerging cognitive models and artificial intelligence engines. We first show how the semantic analysis of user-generated mind maps distinguishes among the disposition of students from different cultures to E&I, and yields analytics that guide stakeholders as they promote the creation and performance of new ventures. We then present a method for training IBM Watson on entrepreneurship

and semantic mind map analysis. Just as it currently provides medical diagnoses, Watson will give entrepreneurs and intrapreneurs an actionable assessment of their venture and strategy. These same analytics also guide the improvement of cross-cultural multidisciplinary entrepreneurship education, corporate entrepreneurship and policies for economic development through entrepreneurship.

Maurie Cohen
Professor of Humanities

Title: State Governments as Laboratories of Sustainable Consumption Governance: A Case Study of the State of Oregon
Subnational units of government both in the United States and other countries are playing increasingly important roles in efforts to mitigate the risks of severely disruptive climate change. This project seeks to understand the factors that have placed Oregon in a vanguard position. One particularly noteworthy initiative involves the calculation of greenhouse-gas emissions on a consumption (rather than customary production) basis. Another program involves active encouragement of the construction of "small houses" in the urbanized centers of the state. Insights generated by the project will be instructive to other states and municipalities seeking to follow this pioneering path.

Kyle F. Dobiszewski
Associate Director, Research Initiatives and Accelerated Programs, Albert Dorman Honors College

Camelia Prodan
Associate Professor of Physics

David Apigo
Postdoctoral Researcher in Physics

Title: An Interdisciplinary, Problem-Based Learning Approach to Teaching Research Methods: The First Step on a New Honors Research Path
Problem-based learning (PBL) and course-based undergraduate research (CUR) have both been shown to positively impact undergraduate students' satisfaction and success. In this project, we implement an Honors research methods pilot course, which combines PBL and CUR. Students' time is mostly spent practicing the principles they are learning from assigned readings while working in small, interdisciplinary groups on faculty-mentored research projects. These research projects range from the design of impact-attenuating composite body armor to the development of models to study wave propagation in metamaterials. This pilot will generate valuable data for subsequent use on an Honors research education proposal to external funders.

Haim Grebel
Professor of Electrical and Computer Engineering

Title: Super-Capacitors
Energy storage elements have become an inherent part of modern electrical grids. They are used as secondary energy sources for smoothing power fluctuations and have become an integral part of sustainable sources, such as solar cells. The most prevalent energy storage mechanism, the battery, is slow to charge and discharge. Instead, it has been

suggested that quickly charging capacitors, and in particular super-capacitors, should be used instead. Super-capacitors are rather limited in their energy capacitance compared to ordinary batteries. Here we report on a whole new concept for super-capacitor design. Preliminary results demonstrated that the overall capacitance, and hence energy capacitance, has increased by more than 30 percent.

Gal Haspel
Assistant Professor of Biological Sciences

Title: Reconstruction of a Nervous System with Expansion Microscopy and Genomic Editing
We are adapting two cutting-edge methods, namely expansion microscopy and genome editing, to reconstruct the complete connectivity of the nervous system of the nematode C. elegans. To identify neuronal connections that are beyond the resolution limit of light microscopy, we expand the specimens at least fivefold before high resolution confocal scanning. We will use genome editing to permanently alter the animal genetic code and insert tags that will localize to neuronal membrane and synaptic specializations that can later be labeled with specific antibodies.

James Haorah
Associate Professor of Biomedical Engineering

Kevin Belfield
Dean of College of Science and Liberal Arts

Title: A New Pathway for Brain-CSF Waste Metabolites Clearance
The lack of lymphatic clearance in the brain promotes the progression of neurological diseases like Alzheimer's disease. Cerebrospinal fluid and the glymphatic system can only clear small size water-soluble waste metabolites, but not the large waste metabolites like beta-amyloid protein. We uncovered the dynamic exchange mechanisms of these large waste metabolites from perivascular space into the circulation system. Intriguingly, our low-dose vasodilator enhances the dynamic clearance of these waste metabolites by increasing the arterial endothelium-smooth muscle cell reactivity and by promoting the osmotic gradient clearance. This novel finding will have a significant impact in preventing the commonly observed cerebral amyloid angiopathy in Alzheimer's disease.

Andrew Klobucar
Associate Professor of Humanities

Title: After the Page: Digital Reading Practices and New Media Technology in the Writing Classroom
A growing number of pedagogical challenges in assessment continue to distinguish the current shift from print to digital or electronic media formats in university composition and literary studies. Many of these issues stem from the lack of suitable academic reading strategies presently available for electronically distributed texts and reading resources. As many writing theorists contend, electronically distributed resources may demand the revision of traditional competencies and skill sets in order to facilitate better academic methods for working with electronic and online media. This study evaluates current reading practices across the NJIT first-year writing program in response to the growing classroom dependency upon electronic reading resources. In particular, it seeks to determine how screen-based devices such as laptops, tablets and e-Readers impact the critical reading skills of first-year writing

students, while analyzing how techniques developed originally for print-based scholarship and learning may be less adequate when applied to electronic formats. Preliminary research from a pilot study conducted at NJIT over the 2016-17 academic year indicates evidence of a possible achievement gap among students when they apply print-based techniques in critical reading to electronic texts. This year's study extends our research to 10 sections of HUM 102, compiling results based on over 200 individual student responses to electronic reading assignments. The study also facilitates advanced investigations into new modes of student engagement with electronic texts using computer assisted technology assessment tools in order to determine how interactive reading and writing tasks specific to electronic reading competencies can be developed to enhance first-year writing in the digital era.

Jing Li
Assistant Professor of Computer Science

Title: Large-Scale Parallel Scheduling for Interactive Cloud Services
Interactive cloud services such as web searches, online advertising, cloud gaming, virtual reality and stock trading have become multi-billion dollar industries with significant growth each year. Delivering consistent interactive latencies is the key performance metric for interactive cloud services that spans hundreds or thousands of multicore servers. The imperative to guarantee low service latency while supporting increasing computational demands due to complex functionalities of the services requires parallel scheduling infrastructure to effectively harness parallelism in the computation and efficiently utilize system resources. This project, for the first time, designs, analyzes and implements scheduling strategies that are provably good and practically efficient for providing various quality-of-service guarantees regarding cloud service latency.

Eliza Michalopoulou
Professor of Mathematical Sciences

Ali Abdi
Professor of Electrical and Computer Engineering

Title: Weak Target Detection in Underwater Environments
Detection in oceanic waveguides is complex because of uncertainties in the underwater channel and suboptimal location of receiving phones. Accurate detection and estimation are a result of optimization with respect to frequency, environmental parameters and receiver location. We study the impact of these parameters on detection and propose methods for improvement. We complement our work by investigating detection performance with real data collected in a pool. In addition to conventional hydrophones, we also use vector sensors. The rationale behind this is that particle velocity components may show different noise and channel characteristics such as a different number of modes and different dispersive behavior, which are tightly related to detection.

NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Eric Nersesian
Lecturer of Informatics

Michael Lee
Assistant Professor of Informatics

Laurent Simon
Associate Professor of Chemical Engineering, Vice Provost for Undergraduate Studies

Dasha Barger
Director of Learning Communities and First-Year Seminars

Title: Longitudinal Study of Virtual Collaboration and Learning Communities Among First-Year College Students
Higher education institutions frequently formalize social learning structures called learning communities (LCs) to reinforce performance-enhancing academic norms across interdisciplinary stretches of their undergraduate student population. Socialization factors such as collaboration, networking and organizational thinking are of particular interest to institutional LCs, due to their critical influence on students' ability to form LCs independently throughout their academic career. Traditionally, this takes the form of a freshman year seminar involving physical classroom-based LC skill-building environments, but recent studies have shown that virtual LC environments can offer improved results over physical LC environments. Since there is currently no research on the interaction between LCs and virtual reality (VR), the researchers are studying how collaborative VR experiences can impact future LC curricula.

Hieu Pham Trung Nguyen
Assistant Professor of Electrical and Computer Engineering

Title: Photoelectrochemical Hydrogen Generation and Carbon Dioxide Reduction via Highly Efficient Solar Water Splitting on III-Nitride Nanoscale Semiconductors
Global energy consumption has been rapidly accelerating due to ongoing industrialization and daily activities. The overall energy production trend is to utilize natural resources to produce hydrogen through economical and environmentally sustainable methods. Direct solar-to-hydrogen generation is the ideal approach for nearly zero carbon production. In this research program, we are investigating epitaxial growth and characterization of nitride nanoscale structures for highly efficient and high-speed photocatalytic splitting of water directly by solar power, thereby mitigating some major barriers for bringing hydrogen to customers and businesses directly on-site. These nanowires are also promising for lighting and display applications.

Hai Phan
Assistant Professor of Informatics

Title: Large-Scale Monitoring and Response for Drug Abuse Behaviors in Social Media
To battle against the drug abuse crisis, we propose to develop a Social Media-based Drug Abuse Detection System to: construct a public health information repository that integrates social media data and open government health data for real-time monitoring and analysis of online drug abuse events; predict and visualize drug abuse trends over geospatial,

social and temporal dimensions to improve timely and informed public health responses as the epidemic evolves; and provide targeted interventions for specific groups of social network users at risk by improving access to prevention, treatment and recovery resources.

Bipin Rajendran
Associate Professor of Electrical and Computer Engineering

Title: SiliconEye — A Brain-inspired Visual Learning and Processing System
Inspired by the algorithmic paradigms and organizational architecture of the brain, we have proposed to develop fundamental algorithms for learning and inference using spiking neural networks and to demonstrate an end-to-end visual information processing system. Our goal is to demonstrate an energy-efficient image-to-text translator, completely operating in the spike domain, based on a new supervised learning algorithm, capable of real-time, on-the-field learning. Initial experiments show that close to state-of-the-art accuracies are possible with our approach for recognizing hand-written digits.

Lucia Rodriguez-Freire
Assistant Professor of Civil and Environmental Engineering

Title: Isolation of Proteins for Selective Removal of Metals from Industrial Wastewater
The objective of this research is to develop an industrial wastewater treatment process to selectively remove, recover and concentrate metals, while minimizing waste production. Proteins have developed complex mechanisms to selectively acquire specific metals and transport them from the environment into the cell. We propose the use of biosynthetic membranes functionalized with specific proteins for the selective recovery of valuable metals. We have selected known high-affinity and high-selectivity proteins for copper and nickel transport – specifically Ctr1 and Ctr2 for Cu+ transport and acquisition, and the NikA unit in the ATP-binding cassette (NikABCDE) as the Ni+ transporter. We are measuring metal uptake rates, and the effect of pH, buffer and chelating agents to optimize metal selectivity and removal.

Horacio Rotstein
Professor of Biological Sciences

Title: Motoneuron Retrograde Signals Affect the Activity of Central Pattern Generators
Rhythmic oscillations are ubiquitous in the nervous system and have been implicated in cognition and motor behavior in both health and disease. The so-called central pattern generators (CPGs) are specific types of neuronal circuits that can produce the rhythmic motor patterns that underlie behaviors such as walking, swimming, crawling and breathing. Motoneurons respond to these CPG rhythmic patterns and control muscle activity. The classical dogma establishes that motoneurons do not project back to the CPG. Recent work (Rotstein, Schneider, Szczupak, J. Neuroscie, 2017) has provided convincing evidence that one type of motoneurons (CV) in the hypothesized CPG that controls the rhythmic motor behavior in the leech hirudo medicinalis sends excitatory projections back to the CPG. Because the identity of the hypothesized CPG is not known, these studies have been carried out in an indirect way by looking at the effect that activation of one of the motoneurons (CV on "one side" of the CPG) has on the other (DE3, on the "other side" of the CPG) under the assumption that the CPG consists of two recurrently inhibitory neurons (one activating CV and the other DE3) and by further providing evidence that these two are not connected. In this work we propose a mathematical model of the neuronal circuit that can account for the observed pattern behavior in the motoneurons

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and we explain the underlying biophysical and dynamic mechanisms. Based on these results, we hypothesize the structure of the CPG and network connectivity properties.

Mathew Schwartz
Assistant Professor of Architecture and Design

Sagnik Basuray
Assistant Professor of Chemical and Materials Engineering

Title: Understanding Root Bacteria for Interior, Smart Green Wall Systems
This project involves the control and study of the root growth systems within smart green walls, in particular, indoor smart systems built by an industrial collaborator, Naava. These walls use non-soil growth medium such as clay stones and charcoal pellets. By characterizing these aggregates by their water retention, pore size and other traits, indoor green wall systems can grow bacteria that are helpful in air quality control in a more effective way. The aggregates in this project have been categorized and analyzed for their optimal growth properties, among ongoing work studying the alternative benefits of indoor green wall systems such as the acoustical absorption and diffusion by plant leaves. Additionally, customized tools and test beds for experiments have been developed.

Mark Somers
Professor of Management

Title: Psychological Well-Being at Work: New Models and Methods from Data Science
Diminished psychological well-being at work has been estimated to result in 6 to 10 percent of health care costs in the United States and 120,000 annual deaths. Current theory and methods have produced disappointing results, especially with respect to building predictive models. We use two data science methods, artificial neural networks (ANNs) and latent class cluster analysis (LCCA), to increase predictive accuracy and to open up new avenues of inquiry. Preliminary results indicated that ANNs generated significant improvements in predicting work stress when compared with multivariate regression analysis. LCCA generated six profiles of well-being that can be used for theory development.

Stephen Taylor
Assistant Professor of Finance

Ali N. Akansu
Professor of Electrical and Computer Engineering

Title: Equity Clustering Using the Fisher Information Metric
Information geometry offers a correspondence between differential geometry and statistics through the Fisher information matrix. In particular, given two models from the same parametric family of distributions, one can compute the distance between these models using only their parameters and the Fisher information matrix for this

family. One practical limitation of this distance is that it is often difficult to calculate. We review such complications and provide a general form for the distance function for one-parameter models. We next focus on higher dimensional extreme-value models, including the Pareto distribution, and discuss how to use shooting point methods to solve the geodesic equation. Finally, we present an application where we first fit extreme-value distributions using maximum likelihood estimation to all S&P 500 stocks and then compute the pairwise distances between their best fit parameters. This is used as an input into a hierarchical clustering algorithm to provide a tail risk-based clustering of the securities.

Benjamin Thomas
Assistant Professor of Physics

Title: Optical Remote Sensing for the Identification and Characterization of Flying Mosquitoes
Mosquito-borne diseases are a major challenge for human health as they affect millions of people. Reliable information on their population and spatial distribution is of major importance in the development of ecoepidemiological models. This project focuses on the remote characterization of flying mosquitoes using a continuous-wave infrared optical remote sensing system. Optical properties are measured from a distance to identify both species and gender in order to properly estimate the population and the impact of vector control strategies.

Mesut Sahin
Associate Professor of Biomedical Engineering

Title: A Novel Electrode for Electrical Stimulation of the Cochlea
Cochlear implants (CIs) have been used as a rehabilitative aid in severe to profound hearing loss since the 1980s. CI users depend on a limited number of electrode contacts to substitute acoustic hearing with its electrical counterparts. An ideal electrode should be able to selectively excite auditory nerve fibers distributed along the basilar membrane. However, the gap between the electrode and the spiral ganglion cells severely affects spatial selectivity. To address this problem, we will design an inflatable electrode consisting of a silicone elastomer that is thinner initially, thus eliminating the cochlear trauma during insertion, and snugly fitting the cochlear canal after insertion and thereby providing closer positioning of the electrode contacts to the spiral ganglion cells. This will in turn improve hearing quality for users.

Frank Shih
Professor of Computer Science

Gareth Russell
Professor of Biological Sciences

Title: Development of a Deep-Learning Framework for Image Morphology and Applications to Ecology and Conservation
The importance and impact of mathematical morphology have been well documented in areas ranging from automated vision detection and inspection to object recognition, image analysis and pattern recognition. In this project, we aim to develop a novel deep-learning framework for automatically learning applicable morphological operations with suitably weighted structuring elements in a massive image data setting. There has been a rapid

development of automated species identification systems based on imagery. We propose to apply a deep-learning framework for achieving high classification rates. Two databases of species imagery will be used to discover optimal image preprocessing steps by deep learning.

David Washington
Associate Professor of Engineering Technology and Civil and Environmental Engineering

Vahid Alizadeh
Assistant Professor and Coordinator of Civil and Construction Engineering Technology, Fairleigh Dickinson University

Mohamed Mahgoub
Associate Professor of Engineering Technology and Civil and Environmental Engineering

Title: Performance, Durability and Workability of Controlled Low-Strength Materials Using Recycled Concrete Aggregate Under Interlocking Pavement Systems
The proposed research will assess the effects of mixtures proportioning on controlled low strength material (CLSM) properties; evaluate the use of recycled concrete aggregate (RCA) as a fine aggregate replacement in CLSM mixtures; define what properties of the ingredients impact the overall CLSM mixture; and validate, improve and develop accurate strength, durability and flowability prediction models for CLSM. Moreover, data from high density surveying methods will be used to quantify surface distortions of surface brick pavers to provide additional insights into the behavior of CLSM as an alternative to conventional substrate reinforcement.

Xiaoyang Xu
Assistant Professor of Chemical and Materials Engineering

Minglin Ma
Assistant Professor of Biological and Environmental Engineering, Cornell University

Title: Nanoparticles-Mediated Oral Delivery of Insulin
Since its discovery, insulin remains the major treatment for type 1 diabetes (T1D). Current insulin delivery systems are limited to invasive parenteral administration methods. The non-invasive oral route of insulin delivery has long been regarded as a difficult challenge, but of substantial clinical and commercial potential. Dr. Xu and his team in the Laboratory of Nanomedicine and Healthcare Biomaterials are developing a nanoparticle-based delivery system for delivering insulin orally. The proposed nanoparticle delivery technology will significantly improve convenience and the compliance rate of patients with T1D by enabling the efficient oral delivery of insulin, ultimately resulting in improved treatment efficacy.

Yong Yan
Assistant Professor of Chemistry and Environmental Science

Title: Exploration of Quantum Yield Exceeding 100 Percent for a Photoelectrochemical Hydrogen Evolution Reaction via Multiple Exciton Generation
Multiple exciton generation (MEG) in quantum dots (QDs) has the potential to greatly increase the power conversion efficiency in solar cells and in solar-fuel production. During the MEG process, two electron-hole pairs (excitons) are created from the absorption of one high-energy photon, bypassing hot-carrier cooling via phonon emission. Here we demonstrate that extra carriers produced via MEG can be used to drive a chemical reaction with quantum efficiency above 100 percent. We developed a lead sulfide (PbS) QD photoelectrochemical cell that is able to drive hydrogen evolution from an aqueous Na2S solution with a peak external quantum efficiency exceeding 100 percent. QD photoelectrodes that were measured all demonstrated MEG when the incident photon energy was larger than 2.

Yuan-Nan Young
Professor of Mathematics

Title: An Elastic Shell Model of a Primary Cilium via Stochastic Measurements and Modeling
Using experimental, analytical and computational tools, we quantify the stochastic dynamics of a biologically significant slender microcantilever, the primary cilium, held within an optical trap. Primary cilia are cellular organelles, present on most vertebrate cells, hypothesized to function as a fluid flow sensor. The mechanical properties of a cilium remain incompletely characterized. Optical trapping is an ideal method to probe and characterize the mechanical properties of a cilium due to the spatial localization and non-contact nature of the applied force. We simulated the thermal fluctuations of an optically trapped cilium and compared those results to analytical modeling to derive the mean-squared displacement of the trapped tip of a cilium. We provide, for the first time, evidence that the effective flexural rigidity of a ciliary axoneme is length-dependent, as well as a rational explanation for the effect. We demonstrate that apparent length-dependent flexural rigidity can be understood by a combination of modeling the cilium in terms of an elastic shell and also including stochastic basal body motion. It is hoped that our improved characterization of cilia will result in a deeper understanding of the biological function of cellular flow sensing by this organelle. Our model could be profitably applied to motile cilia and our results also demonstrate the possibility of using easily observable ciliary dynamics to probe interior cytoskeletal dynamics.

Wen Zhang
Associate Professor of Civil and Environmental Engineering

Title: Microwave-Assisted Reactive and Antifouling Membrane Filtration Development
This project designed a novel antifouling membrane filtration process that significantly improves filtration performance, pollutant degradation and antifouling characteristics. The filtration process involves the production of reactive nanobubbles and hydroxyl radicals under microwave (MW) irradiation. With the catalyst (BiFeO3)-coated ceramic membranes, our microwave-assisted membrane filtration system could achieve high pollutant (e.g., 1, 4-dixane) removal rates and a significant fouling mitigation effect (slower flux decline than the process without MW irradiation). Our MW-assisted membrane filtration systems have potential for diverse applications such as chemical separation or processing, pollutant removal, water disinfection, water reuse and decentralized point-of-use devices in small drinking water systems.

NJIT PRESIDENT'S FORUM AND FACULTY RESEARCH SHOWCASE

Yuanwei Zhang
Assistant Professor of Chemistry and Environmental Science

Title: Remote Control of Ion Channels Using Near-Infrared Light with Biocompatible Nanoparticles
Optical stimulation of cells, especially neurons, is transforming basic and translational bioscience and bioengineering, and opening up new horizons for clinical treatment. However, the currently used approaches are invasive, since a surgically implanted optical fiber or wire electrode is required to deliver poorly bio-permeable light such as ultraviolet and visible light. Ideally, near-infrared light (NIR) would be the solution, because of deeper penetration depth as well as minimal photodamage to tissues. Herein, we aim to develop NIR activable, bio-friendly nanoparticles from a natural source – black sesame seeds. These nanoparticles could absorb NIR lights and convert them into heat, which will be used to stimulate cells via temperature-sensitive ion channels. These innovative nanomaterials may enable minimally invasive remote control of cell function and expand the toolboxes of optical stimulation. We focus on the engineering and surface modification of biocompatible nanoparticles extract from black sesame seeds to achieve high photothermal conversion efficiency and low bio-toxicity, and we will demonstrate their applications in specific photothermal activation of cells by targeting temperature-sensitive ion channels.

Tao Zhou
Associate Professor of Physics

Andrei Sirenko
Professor and Department Chair of Physics

Title: Broadband Far-IR Spectroscopy Using Vortex Beams of Synchrotron Radiation
We develop a new optical setup to facilitate experimental studies of topological excitations in quantum materials at the MET beamline of NSLS-II, Brookhaven National Laboratory, using vortex beams. Axicon-based optics components for conversion between circularly polarized coherent synchrotron radiation into a vortex beam with an orbital angular momentum of ±1 are integrated inside an existing NJIT-owned ellipsometer setup at the MET beamline. These unique optical components are operational in a broad-band spectral range from THz frequencies up to mid-IR: from ~20 cm-1 up to ~4,000 cm-1. New experimental opportunities will emerge for studies of 4f and 5d electronic transitions in multiferroics, polar and chiral magnets, spectroscopy of the edge modes originated from the Landau levels in two-dimensional semiconductor heterostructures, and for study of topological insulators and high-temperature d-wave superconductors.

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