PHD CLUB

GSA

NJIT
New Jersey Institute of Technology

GSA and PhD Club Present

Graduate Research Day 2023

Tuesday, November 14

9:00am-2:00pm

Campus Center Atrium

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Event Program

9:00 AM – 9:40 AM:	**Registration and Breakfast**
9:40 AM – 9:50 AM:	**Introduction from the Office of Graduate Studies**
	Dr. Sotirios Ziavras, Vice Provost for Graduate Studies
9:50 AM – 10:00 AM:	**Welcome from the Graduate Student Association**
	Daniel Mottern, President of the GSA
	Purvam Gandhi, VP of Academic Affairs of the GSA
10:00 AM – 12:30 PM:	**Poster Presentations and Judging Session**
12:30 PM – 1:30 PM:	**Break for Lunch**
1:30 PM – 2:00 PM:	**Announcement of Winners & Closing Remarks**

Graduate Student Association

Who Are We?

The Graduate Student Association (GSA) is the student body government that provides the structure through which graduate students are able to work towards improving the academic and social experience of graduate student life at NJIT

Our Mission

As a student government organization, GSA's mission is to represent the interests of all graduate students in university affairs

Our Goals

We work to promote communication between students, faculty, and the administration. It is also our objective to promote and encourage the professional growth, social and cultural development, and academic excellence of students in the graduate programs at NJIT.

Our Responsibilities

GSA's responsibilities include representing and articulating the interests of all graduate students. We maintain relationships with NJIT students, our university administrators, and officials. The Assembly is also tasked with overseeing the expenditure of the graduate student activity fee with the best interests of graduate students as a priority.

Acknowledgements

Thank you to all of the faculty, organizers, and most importantly, the participants, who made this year's Graduate Research Day possible.

Faculty Judges:
Dr. Arnob Ghosh, Assistant Professor, Electrical and Computer Engineering
Dr. Bo Shen, Assistant Professor, Mechanical and Industrial Engineering
Dr. Elisa Kallioniemi, Assistant Professor, Biomedical Engineering
Dr. Joshua Young, Assistant Professor, Chemical and Materials Engineering
Dr. Lijie Zhang, Assistant Professor, Chemistry and Environmental Science
Dr. Lijing Wang, Assistant Professor, Data Science
Dr. Lin Dong, Assistant Professor, Mechanical and Industrial Engineering
Dr. Mengjia Xu, Assistant Professor, Data Science
Dr. Michael Eberhart, Assistant Professor, Chemistry and Environmental Science
Dr. Nellone Reid, Senior University Lecture, Chemical and Materials Engineering
Dr. Trevor Del Castillo, Assistant Professor, Chemistry and Environmental Science

Organizers
Purvam Gandhi
Daniel Mottern
Shivam Verma
Marco Fernandez
Abdul Azeem Mohammed
Oscar Sanchez Pinosa
Roopal Bhat
Sripathi Sridhar

Administrators
Dr. John Pelesko, University Provost
Dr. Atam Dhawan, Sr. Vice Provost of Research
Dr. Sotirios Ziavras, Vice Provost for Graduate Studies
Clarisa Gonzalez-Lenahan, Director of Graduate Studies
Angela Retino, GSO Office Manager
Latosha Wilson, Associate Director of Conference Services
Thorin Aiello, Gourmet Dining, Director of Catering and Special Events
Samuel Pierre, MTSS Events AV Services Manager

Student Presenters

Abhishek Roy

PhD Candidate, Biomedical Engineering
Advisor(s): Dr. Vivek Kumar

Title: Insulin-like Growth Factor Mimicking Peptide Biomaterial for Ischemic Tissue Disease

Abstract: Peripheral Artery Disease (PAD) is a significant cause of muscle atrophy in the limbs and morbidity in the United States. Around 6.5M people in the US are currently suffering with PAD which is costing the healthcare system approximately $21B/yr. PAD is characterized by ischemia to the peripheral tissue, commonly due to fatty plaque buildup along blood vessels in the arms, legs, stomach resulting in decreased muscle perfusion, innervation, and subsequently pain. While small diameter (~6mm) blood vessel replacements of occluded femoral or popliteal arteries may reperfuse ischemic tissue, arteriosclerosis in micro vessels remains unaddressed clinically. Addressing microvascular arteriosclerosis requires an injectable biomaterial that is pro-angiogenic, degradable, and provides a sustained angiogenic response while preserving myogenesis. We have developed a self-assembling peptide (SAP) hydrogel-based platform, termed SLIGF, to promote these effects through IGF receptor binding peptide and to potentially regenerate microvasculature and muscle preservation within the lower extremities.

The cryo-EM generated extracellular domain IGF1 – IGF1R receptor complex was employed for the initial docking and mutation protocol. The IGF-1 peptide was computationally removed from the structure and replaced with either a 12-glycine structure or the linear sequence of the IGF-1c domain that binds to IGF1R. These mimics were then docked *ab initio*, perturbed, and mutated for 1000 iterations using RosettaScripts and subsequently sorted by their default Rosetta Ref2015 score. SLIGF was synthesized using solid-phase peptide synthesis, and its purity and identity were confirmed via HPLC and MS. The structural characteristics of the peptide were determined using FTIR, CD, SEM and AFM. IGF receptor phosphorylation has been performed to investigate downstream signaling mechanism via Akt phosphorylation. Our preliminary data has shown the ability of the hydrogel to be thixotropic, injectable, biodegradable, cytocompatible, and biocompatible (sub-Q implants in rats). Ongoing work seeks to optimize the IGF-1c mimic through computational modeling and to improve mimic presentation by doping peptide domains with glycine spacers. In addition, we are currently determining *in vitro* efficacy, *in vivo* pharmacokinetics, and limb ischemia treatment in a murine model.

Abolfazi Afshari

PhD Candidate, Civil and Environmental Engineering
Advisor(s): Dr. Joyoung Lee

Title: Real-Time Intersection Mobility Assessment through Digital Twin Technology in Urban Environments

Abstract: This research utilizes high-quality LiDAR data to assess intersection performance using a digital twin simulation. The LiDAR precisely tracks vehicle movements in real-time, capturing speed, acceleration, lane changes, and trajectories. This detailed data is input into VISSIM to create a digital replica of the intersection. The simulation enables a comprehensive evaluation of traffic patterns, congestion, delays, and signal timing. By combining real-world LiDAR trajectories with digital modeling, the study provides new insights into intersection designs, traffic control tactics, and operations. The integrated approach demonstrates the value of using advanced technologies and data analysis to improve urban mobility and safety. Overall, the research shows how high-resolution LiDAR data and simulations can further the understanding of intersection performance.

Ali Parviz

PhD Candidate, Computer Science
Advisor(s): Dr. Ioannis Koutis

Title: Towards Foundational Models for Molecular Learning on Large-Scale Multi-Task Datasets

Abstract: Graph Neural Networks (GNNs) that are based on the message passing (MP) paradigm generally exchange information between 1-hop neighbors to build node representations at each layer. In principle, such networks are not able to capture long-range interactions (LRI) that may be desired or necessary for learning a given task on graphs. Recently, there has been an increasing interest in development of Transformer-based methods for graphs that can consider full node connectivity beyond the original sparse structure, thus enabling the modeling of LRI. How- ever, MP-GNNs that simply rely on 1-hop message passing often fare better in several existing graph benchmarks when combined with positional feature representations, among other innovations, hence limiting the perceived utility and ranking of Transformer-like architectures. Here, we present the Long Range Graph Benchmark (LRGB)1 with 5 graph learning datasets: PascalVOC-SP, COCO-SP, PCQM-Contact, Peptides-func and Peptides-struct that arguably require LRI reasoning to achieve strong performance in a given task. We benchmark both baseline GNNs and Graph Transformer networks to verify that the models which capture long-range dependencies perform significantly better on these tasks. There- fore, these datasets are suitable for benchmarking and exploration of MP-GNNs and Graph Transformer architectures that are intended to capture LRI

Alifia Ibkar

PhD Candidate, Biological Sciences
Advisor(s): Dr. Xiaonan Tai

Title: Understanding Post Fire Recovery Mechanism from Remote Sensing

Abstract: "The rapid increase in global temperatures due to climate change has markedly intensified a range of environmental disturbances. The number of wildfires in the United States has significantly increased during the last few decades. A recent wildfire incident in the southeast Wyoming Medicine Bow National Forest (MBNF) serves as an example of this rise, as it considerably affected many of the forest's scattered vegetative refugia.
Based on the climatic, biological, and hydrogeological features of these impacted ecological refugia, we have selected five sites in the Medicine Bow National Forest in order to obtain a thorough understanding of the damage and recovery processes of these sites. We aim to study the forest fire-affected ecological refugia within these sites and investigate their recovery patterns and underlying mechanisms over the last forty years using remotely sensed vegetation indices from Landsat satellites.
We hypothesized that soil moisture affects the severity of fire damage as well as the post-fire recovery of seedlings and understory vegetation.
The results from this study indicate that soil moisture is a major component which influences tree mortality from bark beetles and fire burns. This study sheds light on the complex interplay between climate change-induced wildfires, ecological refugia, and recovery processes, with significant implications for forest management and conservation strategies.

Alperen Abaci

PhD Candidate, Chemical and Materials Engineering
Advisor(s): Dr. Murat Guvendiren

Title: 3D Bioprinting of Dense Cellular Structures within Functional Hydrogels with User-Defined Heterogeneity

Abstract: 3D bioprinting has a strong potential to address tissue and organ shortage for transplantation. Successful fabrication of a functional tissue requires bioprinting strategies that can replicate the biological and structural features of the native tissue including formation of dense cellular structures. Embedded 3D printing approaches advanced extrusion-based bioprinting technology for fabrication of architecturally and biologically complex structures, yet this technology requires the use of support baths which generally hinders the relevant bioactivity and heterogeneity. In this study, we developed a new method to create dense cellular structures where cell-only bioinks could be deposited into photocurable support hydrogels with tunable stiffness, degradation and bioactivity. Our approach can utilize multiple cell types or functional hydrogels to create highly heterogeneous and complex structures that could potentially be used to fabricate functional tissue models, as well as tissue interfaces, with relevant biochemical and physical complexities.

Asieh Mahmoodi

PhD Candidate, Chemistry and Environmental Science
Advisor(s): Dr. Edgardo Farinas
Title: Evolution in test tube: protein engineering and design
Abstract: The central aims of our research are to develop methodologies and "rules" for enzyme design, and apply these methods to efficiently create novel and practical biocatalysts. Our current research interests are in engineering proteins using directed evolution and rational approaches. Our research goals include developing high-throughput screening technologies to assay mutant enzyme libraries to discovery novel biocatalyst, combine rational and directed evolution approaches to create de novo enzymes, metabolic pathway engineering in bacteria, and novel protein display technologies. Goals include green chemical synthesis, bioremediation, and biofuels.

Bahareh Kargar

PhD Candidate, Mechanical and Industrial Engineering
Advisor(s): Dr. SangWoo Park
Title: Learning Heterogeneous Elasticity Values for Incentive Based Demand Response
Abstract: Residential electricity consumption constitutes over 38% of total U.S. electricity consumption, forming a large pool of flexibility that we can exploit. One of the reasons why DR has been unsuccessful in the residential sector is because there is a lack of understanding of consumer-specific behavior patterns. In this research, we establish a framework for understanding the heterogeneous elasticity of electricity consumption in the face of monetary rewards and utilize that information for the dynamic pricing of rewards. We aim to predict the elasticity of electricity demand specific to each consumer and appliance given external factors such as time of day, temperature, building characteristics. Then, this elasticity information will be used to design a reward pricing mechanism that will dynamically change the amount of reward based on the current state of the system.

Bruno Bezerra de Souza

PhD Candidate, Civil and Environmental Engineering
Advisor(s): Dr. Jay Meegoda
Title: Molecular Dynamics Simulation of PFAS Degradation: Impact of Chain Length and Functional Head Groups during Sonolytic Treatment
Abstract: Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals widely present in the environment due to their extensive use in various products. The persistence and resistance to degradation of PFAS raise concerns about potential adverse effects on human health and the ecosystem. It is hypothesized that long-chain PFAS exhibit higher bioaccumulation potential and adsorption capacity compared to short-chain ones. Moreover, the functional head groups also play a crucial role in PFAS destruction, with sulfonic acid head groups showing greater resistance to degradation than carboxylic acid head groups due to stronger chemical bonds. However, the influence of chain length and functional head groups on PFAS destruction remains an active area of research and further studies are needed to confirm these hypotheses.

Understanding PFAS behavior and developing effective remediation methods is crucial to address environmental contamination. This work employs the ReaxFF force field to understand PFAS behavior and investigate the impact of PFAS chain length and functional head groups on PFAS sonolytic treatment. The work focuses on the molecular simulation of the decomposition of six PFAS molecules (PFOA, PFOS, PFHxA, PFHxS, PFBA, and PFBS) under different environmental conditions. The results support the use of sonochemistry as a promising technology for complete PFAS degradation without generating harmful byproducts. Additionally, it highlights the differences in defluorination rates for PFAS compounds with varying chain lengths and functional head groups, it also discusses the preferred destruction pathways for each compound and the mechanism involved in its destruction. Overall, this work contributes to a comprehensive understanding of PFAS behavior, degradation pathways, and potential remediation strategies, crucial for effectively mitigating the environmental challenges associated with PFAS contamination.

Chenyang Li

PhD Candidate,Mechanical and Industrial Engineering

Advisor(s): Dr. Bo Shen

Title: On Model Compression for Neural Networks: Framework, Algorithm, and Convergence Guarantee

Abstract: Model compression is a crucial part in deploying neural networks, especially when the memory of computing devices is limited in many applications. This paper focuses on two model compression techniques: tensorized neural networks with tensor train decomposition (TTD) and sparsity in neural networks achieved through weight pruning. Although model compression methods are gaining traction for their potential to enhance computational efficiency, training these specialized models is challenging. Existing training strategies often lead to severe performance deterioration. In this paper, we revisit the training procedure from a novel perspective of nonconvex optimization by designing an appropriate objective function. Then, we introduce NN-BCD, a block coordinate descent (BCD) algorithm, and adapt it separately for tensorized neural networks with TTD and for sparse neural networks to solve it. One advantage of our algorithm is that a closed-form iteration scheme can be derived in some scenarios, which reduces the computational complexity considerably and is gradient-free. With the Kurdyka-Łojasiewicz property of our objective function, we show that our algorithm converges to a critical point at the rate of $O(1/K)$, where K denotes the number of iterations. Lastly, extensive experiments demonstrate the efficiency and superior performance of our training framework.

Claire Bailey

PhD Candidate, Biological Sciences
Advisor(s): Dr. Phillip Barden

Title: Uncovering eusocial pathways and consequences in snapping shrimp

Abstract: Eusociality is the highest level of social organization characterized by a unique syndrome of traits: multiple generations living together, a reproductive division of labor, and collective brood care. One fourth of all eusocial origins occur in a genus of snapping shrimp called Synalpheus. Synalpheus exhibit a spectrum of social organization ranging from monogamous pair-living to communal and eusocial societies; there are at least four known origins, all within a lineage dated to the Late Miocene 5-7 Ma. Synalpheus provide a unique opportunity to investigate foundational patterns related to the evolution of eusociality. The numerous, recent eusocial origins in these shrimps are uniquely suited to comparative investigation, in contrast to ants and termites, which exhibit single eusocial origins between 100-145 million years ago. In addition, the ecology of these shrimps appears to be largely consistent, which may reduce the potential for confounding co-varying factors. This project will provide a foundational phylogenetic framework for Synalpheus while generating large-scale morphological and molecular data. Work seeks to determine whether eusociality impacts morphological evolution across lineages and if origins are associated with universal phenotypic features.

Dahlia Musa

PhD Candidate, Informatics
Advisor(s): Dr. Salam Daher

Title: 3D Measurement System for Wound Care

Abstract: Wounds can be challenging to treat, and often require periodic measurements and thorough documentation to determine healing progression and treatment efficacy. Healthcare providers typically measure wounds (e.g., pressure injuries, venous ulcer, and diabetic foot ulcers) using a ruler; however, ruler measurements are highly subjective and yield poor accuracy and reliability. We are developing a system that measures and tracks wound healing progression from 3-dimensional (3D) scans, and we have a patent submitted for the technology. In our studies, we found that our system increases the inter-rater reliability of complex measurements (i.e., perimeter and surface area), reduces the duration of simple measurements (i.e., length, width, and depth), and increases user perceptions of technology acceptance, usability, and trust as compared with physical (i.e., digital caliper) and 2-dimensional image measurement methods. These results suggest that our 3D software is more reliable, efficient, and well-received than wound measurement methods commonly used by clinicians. Our 3D software facilitates the measurement, documentation, and visualization of wounds to support clinicians' treatment decisions and delivery of care, and ultimately can improve wound care patient outcomes.

Deniz Najafi

PhD Candidate, Electrical and Computer Engineering

Advisor(s): Dr. Shaahin Angizi

Title: Enabling Normally-off In-Situ Computing with a Magneto-Electric FET-based SRAM

Abstract: As an emerging post-CMOS FET, Magneto-Electric FETs (MEFETs) offer compelling design characteristics for logic and memory applications, such as high-speed switching, low power consumption, and non-volatility. In this project, a non-volatile MEFET-based SRAM design named ME-SRAM is proposed for edge applications which can remarkably save the SRAM static power consumption in the idle state through a fast backup-restore process. To enable normally-off computing, the ME-SRAM is integrated into a novel processing-in-SRAM architecture that exploits hardware-optimized bit-line computing approaches for the execution of Boolean logic operations between operands housed in a memory sub-array within a single clock cycle. Our device-to-architecture evaluation results on Binary convolutional neural network acceleration show the robust performance of ME-SRAM.

Elvan Dogan Kumtepe

PhD Candidate, Biomedical Engineering

Advisor(s): Dr. Amir Miri

Title: 3D Bioprinted Solid Tumor Spheroid Modeling: Design of Bioinks

Abstract: Two major types of solid tumors are sarcomas and carcinomas. Solid tumors, including soft tissue sarcoma, breast cancer, pancreatic cancer, and others, pose significant challenges for effective treatment due to their aggressive nature and resistance to chemotherapy. Developing better pre-clinical models is essential for evaluating potential anti-cancer treatments. However, current in vitro models lack the ability to accurately replicate the complex tumor microenvironment (TME) within these solid tumors. The primary objective of this research is to design and create a bioprinted tumor spheroid-on-a-chip platform that can streamline drug discovery and personalized medicine for various solid tumors. We have demonstrated that multi-material bioprinting allows us to control the mechanical properties of the extracellular matrix (ECM), enabling us to mimic the TME, arrange biologics in specific locations, and monitor cell behavior. Our published data and preliminary findings support the potential of this model to accurately represent the cellular composition and ECM properties of solid tumors in vivo. The immediate goal of our research is to provide a proof-of-concept for a bioprinted tumor-on-a-chip platform to address the need for rapid and cost-effective 3D in vitro models and drug screening tools for various solid tumors. Our research has three specific aims: 1) Develop a GelMA-based tumor-on-chip platform using bioprinting and optimize its biophysical and mechanical properties. 2) Monitor the behavior of solid tumor cells and detect focal adhesion markers. 3) Validate the tumor-on-a-chip platform using an animal model.
Upon completion of these aims, we anticipate that this innovative hydrogel microfluidic platform will become a valuable tool for studying invasion with spheroids from various solid tumors, supporting personalized medicine approaches.

Funsho Habeeb Issa

PhD Candidate, Biomedical Engineering
Advisor(s): Dr. Alexander Buffone

Title: Defining the contributions of N-linked, O-linked, and glycolipids to glycocalyx bulk and mechanically regulated migration in Glioblastoma Multiforme

Abstract: Worldwide, one in five people develop cancer during their lifetime, and one of the deadliest forms of cancer is Glioblastoma multiform (GBM). GBM is one of the most aggressive cancer types that affect the brain and is characterized by a spindle shaped, mesenchymal morphology as compared to healthy, glioma cells. The glycocalyx is a sponge-like network of proteins, lipids, and glycans extending from the cell membrane which acts as a "buffer" to the mechanical and chemical cues of the surrounding environment and all signals must navigate this barrier to reach the cell. Any changes to the size or composition of the glycocalyx would in turn have drastic effects on how the cell interacts with its environment. In most cancer cells, specific glycocalyx signatures including increased thickness and more bulky side chains have been demonstrated to cause increased proliferation, migration, invasion, and immune evasion. So far, treatment options to prevent GBM metastasis or increase immune recognition have been ineffective, leaving modifying the glycocalyx as a promising therapeutic target. GBMs express a complex mixture of glycoproteins, glycolipids, and mucins so insight into the specific glycan structures mediating the mechanical forces and "bulkiness" of the glycocalyx is needed to effectively edit it. To this end, we hypothesize that editing one of the chain initiating enzymes of N-Linked glycans (MGAT1), O-linked glycans (COSMC), or glycolipids (UGCG) can edit the glycocalyx (Figure 1) in such a way that it disrupts the ability of GBMs to migrate, signal, and evade immune recognition.

Gianpiero Fiorentino

PhD Candidate, Biological Sciences
Advisor(s): Dr. Phillip Barden

Title: Deep time extinction of largest insular ant predators and the first fossil Neoponera (Formicidae: Ponerinae) from Miocene age Dominican amber

Abstract: Ponerine ants are almost exclusively predatory and comprise many of the known largest ant species. Within this clade, the genus Neoponera is among the most conspicuous Neotropical predators. We describe the first fossil member of this lineage: a worker preserved in Miocene-age Dominican amber from Hispaniola. Neoponera vejestoria sp. nov. demonstrates a clear case of local extinction – there are no known extant Neoponera species in the Greater Antilles. The species is attributable to an extant and well-defined species-group in the genus, which suggests the group is older than previously estimated. Through CT-scan reconstruction and linear morphometrics, we reconstruct the morphospace of extant and fossil ants to evaluate the history and evolution of predatory taxa in this island system. The fossil evidences a shift in insular ecological community structure since the Miocene. The largest predatory taxa have undergone extinction on the island, but their extant relatives persist throughout the Neotropics. Neoponera vejestoria is larger than all other predatory ant workers known from Hispaniola, extant or extinct. Our results empirically demonstrate the loss of a functional niche associated with body size, which is a trait long hypothesized to be related with extinction risk.

Hadis Gharacheh

PhD Candidate, Chemical and Materials Engineering

Advisor(s): Dr. Murat Guvendiren

Title: Cell-Laden Composite Hydrogel Bioinks with Human Bone Allograft Particles to Enhance Stem Cell Osteogenesis

Abstract: There is a growing demand for bone graft substitutes that mimic the extracellular matrix properties of the native bone tissue to enhance stem cell osteogenesis. Composite hydrogels containing human bone allograft particles are particularly interesting due to inherent bioactivity of the allograft tissue. Here, we report a novel photocurable composite hydrogel bioink. Our composite bioink is formulated by incorporating human allograft bone particles in methacrylated alginate hydrogel to enhance adult human mesenchymal stem cell (hMSC) osteogenesis

Jose Antunes

PhD Candidate, Chemical and Materials Engineering

Advisor(s): Dr. Mengyan Li

Title: Novel Group-6 Propane Monooxygenases Responsible for 1,4-Dioxane Biodegradation in Psychrophilic Propanotrophic Consortia

Abstract: In situ bioaugmentation for 1,4-dioxane (dioxane) remediation using laboratory isolates is restricted by the low temperatures (4~14 ºC) at impacted aquifers. Available dioxane degraders are largely mesophilic as they were isolated at room temperature or above, yielding lower growth and dioxane biodegradation activity at aquifer-relevant temperatures. In this present study, two propanotrophic consortia were enriched and characterized given their ability to cometabolize dioxane at 14 ºC in the presence of propane. The diversity of soluble di-iron monooxygenases (SDIMOs) are profiled using amplicon-based sequencing to reveal the key enzymes that participate in dioxane cometabolism.

Jun Yuan

PhD Candidate, Data Science

Advisor(s): Dr. Aritra Dasgupta

Title: Visual Analytics of Algorithmic Ranker for Transparent Decision-making

Abstract: Rankings have a profound impact on our increasingly data-driven society. From leisurely activities like the movies we watch, the restaurants we patronize; to highly consequential decisions, like making educational and occupational choices or getting hired by companies– these are all driven by sophisticated yet mostly opaque algorithmic rankers. A small change to how these rankers order the data items can have profound consequences, like, deterioration of the prestige of a university or a job applicant missing out on being on the list of the top candidates for an organization. These scenarios necessitate data-driven and human-centered innovation for making rankers accessible, interpretable, and accountable to stakeholders across the socio-technical divide, like, job candidates, students, hiring managers, administrators, etc. To address this need, in our work, we focus on both complex rankers that learn the ranking of items from data and simpler ones, based on a scoring formula that computes a weighted sum of attribute values of the items being ranked. We make the following contributions as part of our research conducted in close collaboration with experts in responsible AI and machine learning. Using qualitative methods, like semi-structured interviews and participatory design, we studied the challenges in data scientists' workflows for designing

algorithmic rankers. This resulted in the design and development of web-based interactive visualization techniques that help calibrate ranker properties, like, stability, diversity, etc., by expressing relationships between the scoring formula and the rank positions. We developed a number of statistical metrics that help calibrate the performance of rankers beyond top-k rank positions. We integrated explainable AI (XAI) methods with interactive visualizations for studying the interactions between ranker interpretability and their socio-technical applications. Our work is a step in the direction of addressing the spate of new legislations on algorithmic accountability, whereby it has become imperative to develop transparent methods for demystifying how rankings are produced, who has agency to change them, and what metrics of socio-technical impact one must use for informing the context of use.

Kaustav Bhattacharjee

PhD Candidate, Data Science
Advisor(s): Dr. Aritra Dasgupta
Title: Look before you Link: Interactive Visualization Workflows for Assessing Privacy-Utility Trade-offs in Linkable Open Data
Abstract: Open data sets, like those released by governments, ensure that institutions are held accountable through public disclosure of data. However, such disclosure can lead to the leaking of sensitive information about individuals without adequate checks and balances. By performing low-cost joins on multiple datasets with shared attributes, malicious users of open data portals might get access to information that violates individuals' privacy. As part of this research, we investigate how visual analytics-driven human-in-the-loop solutions can serve as data confidantes to stakeholders, like data custodians and decision-makers, by exposing privacy vulnerabilities and expressing the utility of linking data sets. To this end, as our first contribution, we present a systematic analysis of the approaches, methods, and techniques used in addressing data privacy in visualization, followed by a critical analysis of the gaps and future research opportunities in this domain. Expanding on one of the future opportunities thus identified, we conduct an ethical hacking exercise to understand the attacker's perspective. As our second contribution, we highlight the vulnerabilities observed during this exercise and formulate mitigation strategies by developing a risk inspection workflow named PRIVEE. We leverage this workflow along with visual analytic interventions to develop a web-based interface that helps identify the risks associated with the open datasets and analyze them for actual disclosure. We demonstrate the effectiveness of PRIVEE in real-world scenarios using case studies in collaboration with domain experts. Linked datasets are invaluable to researchers for the information they provide about different sectors and population groups of society. As our final contribution, we will analyze visual analytic interventions that can help calibrate the utility of the linked datasets and help in a privacy-aware data discovery process. Our interactive workflows will eventually help real-world data defenders evaluate the privacy and utility trade-offs for linkable datasets and improve the open data ecosystem.

Khang Dang

PhD Candidate, Informatics
Advisor(s): Sooyeon Lee

Title: Opportunities for Accessible Virtual Reality Design for Immersive Musical Performances for Blind and Low-Vision People

Abstract: Blind and low-vision (BLV) individuals often face challenges in their attendance and appreciation of musical performances (e.g., concerts, musicals, opera) due to limited mobility and accessibility of visual information. However, the emergence of Virtual Reality (VR) based musical performance as a common medium of music access opens up opportunities to mitigate the challenges and enhance the musical experiences by investigating non-visual VR accessibility. This study aims to 1) gain an in-depth understanding of the experiences of BLV individuals, including their preferences, challenges, and needs in listening to and accessing various modes (audio, video, and on-site experiences) of music and musical performances and 2) explore the opportunities that VR can create for making the immersive musical experiences accessible for BLV people. Using a mixed-methods approach, I conducted an online survey and a semi-structured interview study with 102 and 25 BLV participants, respectively. Findings suggest design opportunities for making the VR space non-visually accessible for BLV individuals, enabling them to participate equally in the VR world and to further access immersive musical performances created by VR technology. My research contributes to the growing body of knowledge on accessibility in virtual environments, particularly in the context of music listening and appreciation for BLV individuals.

Marco Marena

PhD Candidate, Mechanical and Industrial Engineering
Advisor(s): Dr. Shen Bo

Title: Predicting Metabolic Rate for Firefighting Activities with Worn Loads using Heart Rate, and Machine Learning

Abstract: Monitoring the metabolic rate of occupational workers who often perform physically demanding tasks is of significance in maintaining their performance and safety. We investigate the viability of accurate metabolic rate estimation from heart rate measurements in physically demanding occupational activities, with data collected from simulated firefighter activities. Various regression methods including linear regression, tree-based methods, kernel-based methods, support vector machine (SVM), and neural networks are employed to predict breath-by-breath metabolic rates for firefighting activities under three different loading conditions: firefighting gear, gear + self-contained breathing apparatus (SCBA), and gear + SCBA + 10 lb. With both heart rate and activity types as predictors, the best-performing machine learning method (Coarse Gaussian SVM) is able to estimate metabolic rate with R2=0.76 +- 0.12 and RMSE=0.43 +- 0.07 for activities under the two SCBA conditions, and the method is robust against differences in the subjects' heart rates and metabolic rates according to Leave-One-Out-Cross-Validation. Without activity types as predictors, the prediction accuracy is significantly lower (decreases by 35% on average).
Future research to incorporate IMU sensors and/or force insoles as additional predictors for metabolic rate could eliminate the reliance on activity types, thus enhancing the generality and applicability of the method for a broader range of occupational and daily activities.

Md. Tuffajjal Hossain

PhD Candidate, Civil and Environmental Engineering
Advisor(s): Dr. Joyoung Lee

Title: Connected Vehicles Data: A New Horizon for Estimating Traffic Counts

Abstract: Capturing timely traffic state data (e.g., count, density, occupancy) is essential for all aspects of traffic congestion management, incident management, transportation planning, and traffic operations. This research aims to develop a state-of-the-art estimation method to generate such traffic state data by employing high-resolution trajectory samples obtained from probe vehicles through vehicular telemetry services. A prediction algorithm is developed to predict unsampled trajectories by fitting headway distributions derived from historical sensor data. Then, the steady-state car following theory is used to estimate traffic count. The primary innovation of this method is that it does not need any exogenous assumptions about the characteristics of traffic flow (e.g., a fundamental diagram) or any external measurement implying expensive equipment to estimate traffic. The performance measure in predicting traffic counts comparing to the actual traffic counts obtained from fixed sensor reveals that the method could accurately forecast hourly traffic flow with a MAPE value of 8.11%. Compared to the existing data collection techniques, this research is expected to drastically reduce the cost and effort required to acquire traffic state data.

Md. Tanim-Al Hassan

PhD Candidate, Chemistry and Environmental Science
Advisor(s): Dr. Hao Chen

Title: Fast Screening of PFAS Using Desalting Paper Spray Ionization Mass Spectrometry (DPSI-MS)

Abstract: Perfluorinated compounds (PFCs), used in many commercial applications, are found in wastewater, surface water, and even the human body. Exposure to PFOA and/or PFOS causes adverse effects on human development e.g., decreased birth weight. The non-cancer effect of updated health advisories for PFOA and PFOS is the suppression of vaccine response causing a decrease in serum antibody concentrations in children. Based on the fatal effect of PFCs, EPA issued the 2016 health advisories for PFOA and PFOS, 70 parts per trillion. So, there is an urgent need to develop a method that can rapidly screen PFCs at the trace level. This study shows simultaneous desalting and fast screening of PFCs in complicated sample matrices using a novel DPSI-MS method.

Minkyeong Park

PhD Candidate, Urban Systems

Advisor(s): Dr. Hyojin Kim

Title: Empirical Validation of Building Energy Simulation Program Using the NIST's Net-Zero House

Abstract: In the domains of architecture and engineering, the utilization of building energy simulation software, such as the U.S. Department of Energy's EnergyPlus, is prevalent for the explicit purpose of augmenting energy efficiency. Consequently, the imperative of rigorously verifying and validating the prediction accuracy of such software becomes significant.
In contrast to prior validation endeavors grounded in analytical approaches, this study conducted an empirical validation of the EnergyPlus software. This empirical validation entailed a comparative analysis between simulated data and measured data collected from a real building (i.e., Net-Zero Energy Residential Test Facility (NZERTF) located at the National Institute of Standards and Technology (NIST) campus in Gaithersburg, Maryland). This empirical validation serves as an imperative endeavor, enabling a comprehension of the degree of concordance between EnergyPlus predictions and the actual thermal and energy performance of a building operating within intricate, real-world circumstances.

Mohammad Saleh Nikoopayan Tak

PhD Candidate, Urban Systems

Advisor(s): Dr. Yanxiao Feng

Title: Investigating Occupant Thermal Comfort in Buildings Using Machine Learning

Abstract: This study utilizes machine learning techniques to uncover new insights into factors influencing occupant thermal comfort in buildings. The ASHRAE Global Thermal Comfort Database II is analyzed focusing on areas such as seasonal variations, building design, ventilation strategies, and the effect of outdoor climate. Models are developed to predict thermal sensation, acceptability, and preferences based on environmental measurements and demographic data. The analysis identifies key determinants of comfort under different conditions, and reveals differences across regions, climates, and seasons. The results can guide building designers and HVAC engineers to provide personalized thermal environments that maximize occupant health and satisfaction.

Navid Heydarishahreza

PhD Candidate, Electrical and Computer Engineering

Advisor(s): Dr. Nirwan Ansari

Title: Mobile Node Localization in Wireless Networks: Path-Loss Model, Trilateration, and Error Mitigation in a 5G Sub-6 GHz Scenario

Abstract: In this poster, we proffer a novel technique, designed for localizing a mobile node within an urban terrain, by leveraging the extended COST 231 Hata Path-Loss (PL) model and the Trilateration technique. Our approach accounts for the possibility of a Non-Line-of-Sight (NLoS) scenario in a medium-sized city, wherein one of the three reference nodes required for the trilateration approach encounters NLoS impediments. Our proposed method proceeds with localization by utilizing solely two Line-of-Sight (LoS) reference nodes, while integrating the localization system simulator with an Extended Kalman Filter (EKF). The simulation results presented herein demonstrate a marked enhancement in performance, surpassing that of trilateration in scenarios where three LoS nodes cannot be established.

Samia Alblwi

PhD Candidate, Informatics
Advisor(s): Dr. Ali Mili

Title: Minimizing Mutant Sets: An Optimization Problem

Abstract: Mutation testing is the art of generating mutants of a base program and checking whether a test suite distinguishes between them. To control the cost of mutation testing, researchers have endeavored to minimize mutant sets using criteria such as mutant subsumption.
We argue that mutant set minimization is an optimization problem and find that the constraint under which this minimization is attempted is unspecified. We propose a definition of mutant set effectiveness and model mutant set minimization as the optimization problem where we attempt to minimize the cardinality of the mutant set while preserving its effectiveness.

Shakila Behzadi

PhD Candidate, Biological Sciences
Advisor(s): Dr. Kristen Severi and Dr. Jorge Golowasch

Title: Branching Out in the Dark: Morphological and Synaptic Plasticity of Mauthner Cell Ventral Dendrites

Abstract: The escape response is a primal instinct to avoid harmful stimuli and survive. Mauthner cells (M-cells) mediate the c-start escape response, with the lateral dendrite (LD) processing acoustic stimuli and the ventral dendrite (VD) processing visual stimuli. While the neural pathway circuitry and processing of auditory information to initiate escape response through lateral dendrites is well-known, little is known about the signal processing by ventral dendrites. This research builds upon previous work on light-deprived teleosts such as Astyanax mexicanus and examines the changes in zebrafish M-cells under different visual conditions, focusing on the ventral dendrite. Our morphological study reveals that ventral dendrites branch more in fish raised in constant dark conditions compared to larvae raised in 12 hour light dark cycles, suggesting a negative correlation between branching and stimulation level. Unilateral eye enucleations resulted in the branching of the ventral dendrites primarily in the ipsilateral VD. To investigate synaptic changes, we used immunostaining and expansion microscopy methods to study the synaptic connectivity of these extended ventral dendrite branches. We will also conduct a behavioral analysis by using looming stimuli to trigger an escape response in zebrafish. Overall, this research provides new insights into the structural and functional changes of ventral dendrites in response to visual stimuli and highlights the importance of ventral dendrites in the neural circuitry of visually evoked escape response.

Sumbel Yaqoob

PhD Candidate, Chemistry and Environmental Science
Advisor(s): Dr. Mengyan Li

Title: Isolation of putative degraders from long-term enrichment of aerobic wastewater treatment plant sludge exhibiting biotransformation of fluorotelomer carboxylic acids

Abstract: Fluorotelomer-derived carboxylic acids (FTCAs) are industrial chemicals commonly detected in landfill leachates and environmental matrices. Unlike their perfluorinated analogues, FTCAs contain unfluorinated carbons which may facilitate microbial enzymatic activity. Wastewater sludges harbor diverse bacterial communities, many of which can transform a wide array of pollutants. To understand the biodegradability of FTCAs by mixed microbial consortia, we embarked on a 2-phase experimental approach examining the potential of aerobic and anaerobic microbial communities from diverse sources to transform 5:3 and 6:2 FTCA. Once evidence of FTCA transformation was found in aerobic enrichments via fluoride liberation and targeted analysis, we aimed to isolate and identify bacteria from the enrichments to assess their ability to degrade FTCAs and characterize the enzymes responsible for transforming these polyfluoroalkyl substances.

Tulika Das

PhD Candidate, Biomedical Engineering
Advisor(s): Dr. Bryan Pfister

Title: Role of Blood Brain Barrier Disruption following Repeated Low-Level Blast Traumatic Brain Injury in Development of Post Injury Behavioral Deficits

Abstract: Members of the military and civilian law enforcement can experience repeated low-level blast exposures due to increased use of heavy weaponry including large caliber rifles and explosives. In humans, low-level blasts (rLLB) are often not associated with overt symptoms, however, can lead to cognitive impairments and attention deficits over time. Recent TBI models are suggest that cumulative effect of rLLB may cause neurological deficits that develop over months, but the mechanisms remain poorly understood. Studies using various TBI models including blast TBI, have indicated a loss of neurons after injury along with behavior deficits. It is still unknown if this neuronal loss could be associated with inflammation. Under normal conditions, blood brain barrier (BBB) is selectively permeable and does not allow foreign bodies to enter central nervous system (CNS). In blast TBI pathology, acute BBB breakdown and monocyte infiltration have been well documented following the injury. Circulating monocytes get recruited and activated in response to damaged brain tissue and mature into macrophages which are indistinguishable from microglia derived macrophages. These ultimately leads to chronic neuroinflammation. A previously published study from our lab showed acute and chronic anxiety like symptoms and short-term memory impairments in mice exposed to single moderate blast (180 kPa) in parallel with activation of both resident microglia and infiltrated monocytes. My hypothesis is, “Repeated exposures to low-level blast overpressure (BOP) causes breach in BBB resulting in inflammation mediated neuronal death which induces cognitive impairments and can be reversed with treatment of membrane resealing agent, Poloxamer188 (P188)”.

Vrushali Koli

PhD Candidate, Data Science

Advisor(s): Dr. Aritra Dasgupta

Title: Navigating Terra Incognita: An AI-Driven Sensemaking Model for Socially Mediated Crisis Communication

Abstract: In times of crisis, the human mind is often a voracious information forager. It might not be immediately apparent what one wants or needs, and people often look for answers to their most pressing questions and worst fears. In that context, the pandemic has demonstrated that social media sources, like erstwhile Twitter, are a rich medium for data-driven communication between experts and the public. However, as lay users, we must find needles in a haystack to distinguish credible and actionable information signals from the noise. In this work, we leverage the literature on crisis communication to propose an AI-driven sensemaking model that bridges the gap between what people seek and what they need during a crisis. Our model learns to contrast social media messages concerning expert guidance with subjective opinion and enables semantic interpretation of message characteristics based on the communicative intent of the message author. We provide examples from our tweet collection and present a hypothetical social media usage scenario to demonstrate the efficacy of our proposed model.

Wenlong Feng

PhD Candidate, Chemistry and Environmental Science

Advisor(s): Dr. Zeyuan Qiu

Title: Exploring the Influence of Hydrologically Sensitive Areas on Residential Property Prices in Inland Communities: A Case Study of Hillsborough Township and Montgomery Township, New Jersey, USA

Abstract: Floodplain maps is critial for flood risk management and flood resilience in the USA, but they often fall short in capturing the full extent of flood risk, causing a substantial amount of unexplected flood-related losses, exacerbated by climate change. This study investigates the potential of Hydrologically Sensitive Areas (HSAs) to improve flood-prone area mapping by examining their impact on home sale prices in Hillsborough Township and Montgomery Township, Somerset County, New Jersey. Using a hedonic pricing method, the research finds that both the 100-year floodplain designation and HSAs significantly and negatively affect single-family home prices, highlighting the importance of HSAs in identifying flood-prone areas outside traditional floodplain designations. This research provides a foundation for future studies on the relationship between flood losses, land use, and community flood resilience

Zihang You
PhD Candidate, Biomedical Engineering
Advisor(s): Dr. Xianlin Zhou

Title: Optimizing Sensor Selection and Placement on Lower Limbs for Real Time Human Activity Recognition

Abstract: This work evaluates the efficacy of different types of sensor data or derived data, from inertial measurement unit (IMU), goniometer, and inverse kinematics (IK) derived joint angles from motion capture, in human activity recognition (HAR) with three deep neural network (DNN) models (MLP, LSTM, and CNN-LSTM). Utilizing a comprehensive open-source dataset detailing lower limb biomechanics encompassing diverse activities and conditions, we train DNN models with short window (50ms) data from different combination of source data and present thorough comparisons of accuracy to optimize the number of sensors and placement of sensors to achieve high accuracy in HAR. In addition, we delve into the impact of incorporating joint angular velocity (derivative from joint angle) on HAR precision. Results indicate that, with the same number of data sources, bilateral IK data (for any combinations of the three lower limb joints) leads in HAR performance, ranging from the highest accuracy at 98.98% for all three joints and the lowest at 80.69% for the ankle joint. The combination of thigh IMU and IK from all three joints can further improve the best HAR performance up to 99.23%. The integration of the thigh IMU with the IK of any individual joint yields an approximate accuracy of 95%. Furthermore, the inclusion of joint angular velocity notably enhances HAR outcomes. For goniometers, incorporating joint angular velocity results in a performance enhancement of at least 3% to 5% across all joint combinations. For IK, this increase can reach up to 10% (single joint). In the unilateral IK data, the inclusion of angular velocity contributes to an average single-joint accuracy increase of 5% to 7%. In the bilateral case, the enhancement can reach up to 10%, elevating the average accuracy of bilateral single-joint to over 90%. For IMU, the HAR performance for one joint is above 86%. These results provide highly valuable insights on optimal sensor selection and placement for HAR and pave the way for minimalist HAR solutions. In addition, our results show the promises of using joint angle and velocity data, which can be measured by joint encoders in lightweight wearable exoskeletons, for real time HAR and optimal assistance.