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Assessment of Lake Water Quality Parameters Using UAV Hyperspectral Imaging

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Monitoring water quality in lakes is critical for assessing ecosystem health, managing drinking water resources, and detecting harmful algal blooms. Unmanned Aerial Vehicle (UAV)–based hyperspectral imaging provides a promising approach for high-resolution observation of water quality parameters. In this undergraduate research project, hyperspectral imagery collected over sample lakes within the Delaware River Watershed was processed using BaySpec's CubeStitcher software to assess its capability to detect variations in chlorophyll-a (Chl-a) concentrations. This work was conducted as part of a National Fish and Wildlife Foundation (NFWF)-funded project in collaboration with Princeton Hydro and NYC College of New York. Hyperspectral image cubes were mosaicked using CubeStitcher; however, the datasets were not fully georeferenced, requiring manual alignment with high-resolution RGB imagery acquired by a DJI drone approximately one hour earlier. Concurrent field measurements collected by The College of New Jersey (TCNJ) indicated Chl-a concentrations ranging from low to high levels across study sites, serving as an indicator of water quality conditions. Spectral responses extracted from central lake regions were examined to evaluate differences between lower and higher Chl-a conditions. While variations in reflectance patterns were observed, interpretation was limited by uncertainties in spatial alignment and unexpectedly high reflectance in the blue wavelength region. These challenges highlight the importance of accurate georeferencing, radiometric calibration, and further investigation of sensor and environmental effects. Overall, this study demonstrates the potential of UAV hyperspectral imaging for lake monitoring while emphasizing key limitations in data processing and interpretation.

Applications of the Quantum Zeno Effect

Aaron Soriano, Christopher Osorio
Prof. Seth Cottrell

In this study, we continue our deep dive into the applications of the Quantum Zeno Effect. Namely, investigating the use of a three state variant as well as further uses for the counterfactual framework used in the previous semester. Our findings show that the addition of this third state introduces a second wave into the simple probability of the two state version. Depending on the initial state, the act of rotation and measuring seems to shift this second wave which then gives rise to more complex behaviors. We hope that further tinkering will yield more interesting results.

No Alarm Clock? Put a chip in your brain to wake up: A Systematic review on Brain-Computer Interfaces

Adnan Nirob
Prof. Niloufar Haque

Brain-computer interfaces (BCIs) are becoming an important topic in modern medicine and neurology because of their possibilities and uses in paralysis, stroke recovery, speech restoration, and other neurological conditions. This paper is written with a systematic review style to show how BCIs and Brain-Implanted Devices work, what benefits appear in current research, which will be useful for a neurologically affected patient, and what the risks and limitations are. Since there was no direct clinical testing in this undergraduate project, and it was also not possible to conduct a clinical trial, published articles, clinical studies, review papers, and survey reports from trusted academic and medical sources were used instead to compare results and demonstrate the whole Brain-Computer Interface system.

Ebike Architecture

Ahmad Dawoud, Miguel Veliz, Gregory Shatsman, Karim Palitov
Prof. Andrea Ferroglia, Prof. Andrea Re, Prof. Carlo Rosso

Standard e-bikes usually connect the electric motor directly to the wheel. Because of this, the motor is forced to speed up and slow down constantly as you ride, which wastes battery life for the reduced efficiency. To lower the battery energy consumption, our project designed a new e-bike layout that separates the motor from the wheel by adding an intermediate gearbox.

We calculated the kinematics and dynamics for a 125 kg bike system to test two different setups: a 40 km/h top speed and the possibility to climb on a 30% slope (Team A), and a 45 km/h top speed and the possibility to climb on a 25% slope (Team B). Through these calculations, we proved that the e-bike's climbing performance is strictly bottlenecked by the motor's hard 500W power limit. To keep the motor running continuously at its most efficient speed (2750 RPM) without stalling on steep hills, we determined the required transmission ratios. Team A needs an intermediate gear ratio of 1.41 for reaching the top speed and a gear ratio of 18.39 for climbing on a 30% incline. Team B needs a 1.254 gear ratio for top speed and a gear ratio of 15.52 for climbing a 25% incline. Using these final numbers, we drafted the physical gear components in GeDy TrAss software. Ultimately, this decoupled gearbox design allows the motor to stay in its peak efficiency zone, saving power and extending the bike's total range

Vibrations and Standing Waves Experiments
Alex Davis
Prof. Vitaliy Dorogan

A wave can be described as an oscillation or disturbance that transfers energy through a medium, such as air, water, or space, while a wavelength is the distance between two corresponding points. These waves can be categorized into three classifications: mechanical waves, which are the oscillation of matter and cannot propagate through a vacuum; electromagnetic waves, which are oscillations of electric and magnetic fields that can propagate through a vacuum; and matter waves, which are the oscillations of a probabilistic field representing where a particle could be and require no medium. These types of waves are important areas of knowledge required in engineering disciplines such as mechanical, electrical, and civil engineering. By using a mechanical wave driver, we can create experiments to display, show, and explain different wave properties, such as constructive and destructive interference, in an effort to deepen the understanding of physics for students and provide a visual aid usually not seen in textbooks.

The Relationship of Age and Systemic Disease with Verbal Memory Functioning

Cassara Norville
Prof. Daniel Capruso

The aim of the project was to determine the effect of systemic disease on verbal memory functioning. Subjects were patients (n =74) with psychiatric (n = 20), cerebrovascular (n = 25), neurodegenerative (n = 13), or other diseases (n = 16). Patient clinical records were reviewed for a history of hypertension, diabetes, or cardiovascular disease, and then used to classify the patients as Controls (n =45) or as having systemic disease (n =29). The Control group was younger (M = 50.02, SD = 15.86) than the Systemic Disease Group (M = 64.86, SD = 12.14), $F(1, 72) = 18.41$, $p < .001$, $\eta 2 = .20$. Memory was measured using Benton Temporal Orientation and the Selective Reminding Test (SRT), which involves the new learning of a 12 word list over 6 trials. The groups did not differ in Temporal Orientation, or in SRT Multiple Choice recognition, but the Systemic Disease group performed worse on SRT measures of rate of memory storage (LTS), $F(1, 56) = 4.09$, $p < .05$, $\eta 2 = .07$ and Delayed Recall, $F(1, 56) = 6.35$, $p < .05$ $\eta 2 = .10$. After a 30m delay, the Control patients were able to recall approximately 7/12 words, whereas the Systemic Disease patients were able to recall approximately 4/12 words. The presence of systemic disease is associated with verbal memory deficits, but these results were confounded with the effects of age.

Analyzing the benefit of tutoring and Peer Led team Learning on academic performance in Statics

Christopher Guerrero, Richmond Smith Birch
Prof. Melanie Villatoro

This study examines how Peer-Led Team Learning (PLTL) workshops and tutoring impact student academic performance in Statics. This research is important because many students find Statics to be a difficult subject and often require additional academic support to succeed. The study was conducted using a Google Form survey distributed to students, collecting responses about their attendance in tutoring and workshops, as well as their perceptions of how helpful these resources are. The findings suggest that students who attend tutoring sessions and participate in PLTL workshops report a better understanding of course material and a more positive learning experience. Overall, the results show that tutoring and PLTL help students improve and feel more confident in Statics.

Public Space as Interface: Access and Control in the High Line and Paley Park

Daniela Guzman
Prof. Anne Chen

This research focuses on how urban public spaces operate as thresholds that mediate between public access and control, using The High Line and Paley Park as case studies. It shows how design elements such as elevation, visibility, sound, and spatial sequence shape user behavior without relying on explicit signage or rules. However, the question of how these subtle strategies influence who feels invited to enter, stay, or pass through remains partially unaddressed. This research is important because it contributes to a broader understanding of how public spaces are not entirely open, but instead carefully structured environments that guide experience. The core of this study is to analyze how thresholds function as spatial interfaces that filter entry, movement, and occupation. Employing an observational and comparative approach, the research develops an analysis of circulation patterns, sensory conditions, and spatial transitions in both sites. This study reveals that the High Line operates through a sequential system that guides continuous movement, while Paley Park uses enclosure and sensory filtering to encourage stillness and pause. These findings suggest that different spatial strategies can produce distinct forms of control within public environments, offering a new perspective on how design shapes social behavior. The findings complement earlier studies on public space by showing that control is not only enforced through rules, but also embedded in spatial and sensory design. Further exploration is needed to understand how these thresholds affect inclusivity and accessibility across different user groups. Following this research, future studies can focus on how similar strategies operate in other urban contexts and how design can balance openness with control more equitably.

Smart Automatic Toll Gate & Car Parking System Using Arduino & RFID
Suchi Chowdhury, DiaaEldin Elabsy
Prof. Farrukh Zia

The Smart Automatic Toll Gate & Car Parking System is an embedded system project that uses sensors and an Arduino to control how vehicles enter a parking area. The system uses an RFID reader to check each vehicle's ID card, IR sensors to detect when a car arrives or leaves, a servo motor to open and close the gate, and an OLED display to show simple messages and parking information. By combining these parts, the system can automatically identify a vehicle, decide if it is allowed to enter, and move the gate without needing a security guard or manual operation. This project can be used in many real world places such as shopping plazas, university campuses, residential communities, office buildings, and private parking lots. The goal is not only to manage tolls or payments but also to improve safety and organization. Because the RFID reader records each vehicle's identification, the system can keep a digital log of who enters and exits the area. This helps with monitoring, reduces unauthorized access, and can support investigations if any incident or crime occurs. The system also helps reduce traffic jams by speeding up the entry process and giving clear feedback through the display, LED, and buzzer. Building this system allows students to apply knowledge from STEM courses, including electronics, programming, sensors, and basic engineering design, while learning how different hardware and software parts work together in real time. Overall, this project shows how simple, low cost technology can support smart city ideas by making parking and gate control more secure, efficient, and easy to manage.

From Silos to Data Centers: Research Through Drawing of Industrial Typologies
Erickson Cabrera
Prof. Dorde Bulajic

This project investigates industrial architectural typologies, such as silos, telephone buildings, and data centers, through research conducted by drawing. Industrial buildings of the 20th century represent a key chapter in architectural history, shaping urban landscapes and reflecting the relationships between production, labor, and space that defined the second and third industrial revolutions. Today, the data center has emerged as their modern counterpart, the architecture of the fourth industrial revolution, built around information, computation, and energy rather than manufactured goods. By producing analytical and speculative representations through plans, sections, axonometrics, and analytical diagrams, the research traces the formal, spatial, and technological transformations of these typologies from the 20th to the 21st century. Selected case studies are examined side by side to reveal the spatial logic, structural systems, and material conditions that define each, showing what they share and where they differ across two distinct technological eras. By drawing parallels between the factory, the silo, the telephone building, and the data center, the project re-frames how we read industrial architecture today and considers how its lessons might shape contemporary sustainable design.

Modeling Bus Arrival Time with Poisson Process

Evelyn Pulla
Prof. Xiaohua Wang

This study examines bus arrivals on the B63 route in Brooklyn using a Poisson process framework. Scheduled arrival times from the MTA (August 31, 2025) were collected for a fixed stop (5 Av / 86 St) during weekday morning hours. Interarrival times were computed and used to estimate the arrival rate and evaluate the exponential assumption. The model is then assessed through visualization and simulation to determine its suitability for describing bus arrival patterns.

Social Policies as Public Health Interventions: Reducing Health Inequality Through Tax-Funded Programs

Fatima Barnes
Prof. Sean MacDonald

This project focuses on how social policies connect to people's health, especially for communities that don't always have equal access to care. Health is usually talked about in terms of doctors and hospitals, but things like income, job stability, housing, and even access to food matter just as much. Because of that, this research looks at how government decisions, like taxation and spending, end up affecting health in ways that are not always obvious. A big part of this project is looking at policies like housing assistance, WIC, paid family leave, and public insurance programs. These have been shown to help reduce inequality, but at the same time, they don't seem to be having the same impact now. Even though the programs still exist, issues like funding changes, income gaps, and unstable work conditions make it harder for people to actually benefit from them the way they should. To better understand these challenges, this project looks at possible solutions such as community based healthcare, progressive taxation, and policies that regulate the cost of medications. It also considers how environmental factors, like food access and living conditions, can shape health outcomes. The goal is not only to point out these issues, but to show how policy shows up in real life and how it can be improved to make healthcare more accessible and fair.

The Economic Impact of Universal Healthcare Policy

Hasib Mahmood
Prof. Sean MacDonald

This research studies the economic impact of universal healthcare policy. Universal healthcare means that all people in a country can get healthcare services without worrying about high costs. This paper examines how universal healthcare can reduce long term medical expenses, improve worker productivity and lower financial stress for families. It also looks at how this policy affects government spending, employment and small business growth. Overall, the study finds that while universal healthcare requires high government investment at the beginning, it can create long term economic benefits by improving public health and financial stability.

Breathing & Feeling the Difference
Juliana Trujillo, Brisalis Fernandez
Prof. Anne Leonhardt

This research looks at factors affecting summer temperature and air quality in New York City, focusing on the difference between Downtown Brooklyn and Fresh Meadows. The main goal is to understand why these two neighborhoods face different temperatures, if there are any variations in air quality, how buildings and urban design affect these factors, and what can be done to improve this situation. We used tools like ArcGIS maps, and data from First Street Environmental, Live Air Quality visuals, NY City Council Data Operations, NYC Department of Buildings, and Landsat imagery to support the research. From this information, it is clear that NYC is getting hotter over time, with more days reaching above 90°F and even 100°F and longer heat waves**. This is not just uncomfortable it can lead to serious health issues like dehydration, heat exhaustion, and breathing problems***. Overall, this research shows how important architecture and urban design are when it comes to climate issues. The way we design our cities can either make the problem worse or help create healthier and more comfortable environments.

**Note https://newyorkcitycouncil.github.io/heat_map/ " "Live Animated Air Quality Map (AQI, PM2.5...) | IQAir USA"
***http://nyc.gov/health/environmentdata.

Design, Analysis, and Optimization of a Lightweight Steel Bridge

Katerina Uruci, Arlette Reyes Tavares
Prof. Navid Allahverdi

The New York City College of Technology Steel Bridge Team undertook a detailed design and analysis process to develop an efficient and lightweight steel bridge that sasfies performance, safety, and constructability requirements. The project began with extensive research on different bridge systems, including truss and girder types. The team evaluated these configurations based on load distribution efficiency, ease of assembly, and compliance with compeon constraints. After careful consideration, a hybrid stringer-supported system was chosen to balance strength, material efficiency, and simplicity in construction. A significant innovation in the design was the development of a wedge-shaped connection. This unique feature enables applied loads to engage Grade 8 bolted joints effecvely in both shear and tension modes. By doing so, the connecon enhances load transfer efficiency and ensures greater stability of joints under combined loading condions. This approach not only improves structural integrity but also reduces complexity during assembly. To verify structural performance, the team employed finite element analysis (FEA) and shape optimization tools within Fusion 360. The primary stringer was subjected to two concentrated loads of 1,500 lb and 800 lb, resulting in a peak bending moment near 5,900 lb-. Support reactions were calculated at 590 lb and 1,710 lb. Through the creation of shear and moment diagrams, the team assessed internal force distributions and confirmed that stresses remained below the steel's yield strength, ensuring safe operation under expected loads. Safety assessments focused heavily on connection regions exposed to simultaneous shear and tensile forces. Additionally, the design emphasized constructability by incorporating pre-installed upper stringers, facilitating efficient assembly without heavy equipment. This consideration minimized environmental impact and labor requirements. In summary, the design process integrated thorough engineering analysis, innovative joint design, and practical assembly strategies to produce a structurally sound and efficient steel bridge. The team's methodology showcases how thoughtful design and analysis can meet rigorous competition standards while promoting sustainability and ease of construction.

X-ray and MRI discrepancies in filler-polymer dynamics of Poly Dimethyl Siloxane (PDMS)

Mostakim Shahed, Daler Djuraev, Shaima Alsaidi, Jennifer Bulbuena
Prof. Subhendra Sarkar, Prof. Zoya Vinokur

Poly dimethyl siloxane (PDMS), a silicone-based synthetic polymer with suitable filler materials offer significant industrial applications including biomedical implants and synthetic tissue. Although such composites seem to have uniform structures, they often have internal defects that have not been well understood. Using MRI and X-ray as complementary and non-invasive imaging tools, our study investigates why these two modalities reveal strikingly different internal structures of the same material. MRI imaging shows many internal defects in PDMS, while X-ray imaging does not clearly show these defects unless there are heavy metals involved or poor filler mixing. This difference suggests that each method, using different electromagnetic physics, interacts with the PDMS chemical components in a different way. The role of fillers and internal structures in PDMS is examined to understand how imaging physics influences imaging results. Comparison of MRI and X-ray principles may help explain the limitations and advantages of each method leading to insights into non-invasive imaging of similar soft materials and improve understanding of tissue/medical device and tissue/composite interactions.

Students Helping Students: Does It Really Help?
Jacky Dong, Oscar Situ, Henry Ye
Prof. Li Geng

This study evaluates the effectiveness of peer support programs (such as tutoring, mentoring, and study groups) using survey data collected across the engineering and technology majors within the School of Technology and Design (SoTD) at City Tech. Findings include frequency, obstacles, and perception of students seeking or utilizing peer support. Respondents generally perceive current SoTD facilities as only 'somewhat' encouraging of after-class collaboration, with qualitative written feedback emphasizing the need for an expansion in peer support services and dedicated collaborative spaces. Ultimately, the findings provide actionable insights to help the SoTD refine its support infrastructure and foster a more collaborative learning environment.

Agentic Search as an optimization on S&P500 Stock Predictions using Recurrent Neural Networks like LSTM, GRU

Parviz Subkhankulov
Prof. Caner Koca, Yusuf Danisman

In this research, we compare traditional hyperparameter optimization techniques, like random grid search and genetic algorithms, with an autonomous agentic AI approach (AutoResearch) for optimizing deep learning models in financial time series predictions. Using a dataset of 20 S&P 500 stocks from 2019-2021, we evaluated LSTM, GRU and Transformer architectures for one-day-ahead log-return prediction. Results show that AutoResearch achieved a composite score of 0.0804 (RMSE: 0.01203, directional accuracy: 76%) with only 21 experiments, outperforming grid search (best composite score: 0.7449 directional accuracy, 50 evaluations) and genetic algorithms (best directional accuracy: 0.7119, 320 evaluations, 20 generations). While direct score comparison is limited by different evaluation metrics, AutoResearch showed a superior efficiency in navigating the hyperparameter search space. It identified GRU architecture with bidirectional processing and dropout regularization as optimal. Our findings suggest that autonomous agentic AI can accelerate hyperparameter discovery in financial deep learning tasks while exploring a broader architecture space. We also believe that it can automate the research experimentation process significantly, accelerating future research.

A Descriptive Study of Enculturation Levels Among Human Service Students

Perla Reyes
Prof. Smita Ekka Dewan

This study investigates the relationship between enculturation processes, academic performance, and well-being among human services students across all academic levels at the NYC College of Technology. Using a quantitative cross-sectional design, participants will complete a Likert-scale survey measuring levels of enculturation and well-being. Data will be analyzed using descriptive statistics and correlational analyses to examine associations between enculturation, well-being, and academic performance. Findings from this study aim to inform the development of targeted student support services and academic interventions that enhance student success during and after college.

The Canal House: A New Prototype for Tropical Savanna
Rebekah Zayas, Zayed Beig, Alfonso Grant, Joel Rosales, Mahir Rafed
Prof. Kenneth Conzelmann, Prof. Patricia Semmler, Chris Leung (RIT alumni)

This research project will focus on topics and considerations around the conceptual design of a near-off-grid single family house located on a parcel in southwest Florida with a climate category known as tropical savanna. The site is in a suburban grid, 18,000 acres of wilderness which was bulldozed and divided into thousands of parcels in 1955. Our .25 acre parcel sits at the corner of two canals, which affect drainage and views, but it is not in a flood zone. The land is flat with sandy soil, making it easy to build on, and it gets strong sun, open wind, and seasonal storms. Because of setbacks and easements, the center of the site is the main area for building. The design uses a low, compact, and slightly raised form to reduce wind impact and improve comfort. Strong materials like concrete, metal roofing, and impact-resistant glass are used to handle the climate. The project also looks at using sustainable systems and on- site renewable energy technologies like solar, wind and geothermal energy. It also considers the neighborhood by connecting the house to the canal, street, and nearby homes while keeping a balance between openness and privacy. Overall, the Canal House is designed to be safe, energy-efficient, and well-suited for tropical savanna conditions.

ESP32-based Smart House utilizing IoT-AI enabled Surveillance Systems

Safoan Hossain
Prof. Ahmed Hassebo

This study presents the design and implementation of an ESP32-based smart house that integrates Internet of Things (IoT) sensors with Artificial Intelligence (AI) to improve safety, automation, and quality of life. The proposed system employs multiple sensors, including light sensors for intelligent lighting control, temperature sensors for environmental monitoring, and water sensors for automatic rain detection and protective shielding. These sensors enable the house to respond dynamically to changing environmental conditions while optimizing
comfort and energy efficiency. In addition, voice detection technology is incorporated to enhance home security by enabling authorized voice-command access and emergency interaction. Furthermore, an AI-enabled camera system is utilized for advanced surveillance, motion detection, and smart recognition capabilities to provide an additional layer of protection for residents. The ESP32 microcontroller serves as the central processing unit,offering wireless connectivity (via Bluetooth and WiFi), real-time monitoring, and remote control through mobile
or cloud-based platforms. By combining IoT sensing, automation, and AI-driven security features, the proposed smart house represents an innovative model for future residential systems. This design supports the broader vision of smart cities by creating safer, more efficient, and intelligent living environments that enhance the well-being of populations worldwide.

OpenLab UX/UI Design

Samridha Lamichhane, Yeimilee Marcano, Isabella Ramos
Prof. Jenna Spevack, Prof. Jody R. Rosen, Prof. Jonas Reitz

City Tech's OpenLab is an open-source digital platform where students, faculty, and staff collaborate, share ideas, engage in academic and creative work, and build digital presence with portfolios. It supports teaching and learning while fostering connection across the college community, making accessibility and usability central to its effectiveness. As a leader in accessibility within CUNY, the OpenLab aims not only to meet WCAG 2.2 Level AA accessibility standards, but to create an inclusive and engaging user experience. With this in mind, the OpenLab student researchers engaged in a research-driven design process to analyze existing user flows, identify usability issues, and propose solutions to enhance the platform's overall functionality and visual design. This project included evaluating the platform's navigation, interface consistency, readability, visual contrast, and interactive elements. Researching comparable digital platforms and inclusive design principles led researchers to develop recommendations, wireframes, and prototypes to redesign key interface elements for improved responsiveness across desktop and mobile devices. These findings indicate that targeted interface refinements can meaningfully improve both usability and accessibility across the platform. This research not only strengthened the researchers' skills in UX/UI design, research, and problem-solving, but also helps advance the OpenLab's mission of accessibility beyond compliance and supports the broader City Tech community by creating a more welcoming, effective, and user-friendly digital environment.

Canine Microbiome Analysis
Shayna Jung
Prof. Jeremy Seto

This study investigates the potential pathophysiological impacts of canine domestication by examining associations between microbiome composition and breed-specific diseases. Cheek and fecal samples from diverse breeds of *Canis lupus familiaris* were analyzed to identify bacterial communities. Following DNA extraction, the full 16S rRNA was amplified via polymerase chain reaction (PCR) and sequenced using the Oxford Nanopore MinION. This analysis detected several bacterial families known for causing canine diseases including *Campylobacteraceae, Enterobacteriaceae, Fusobacteriaceae, and Pasteurellaceae*. Literature analysis suggests associations between these microbial families and prevalent canine health issues such as bacterial gastroenteritis, periodontal diseases, and urinary tract infections (UTIs). While these findings are correlational, they provide insight into how selective breeding and domestication may influence canine microbiome composition and associated health outcomes.

Force-Sensing Transradial Prosthetic Interface
Shiou Ching Chen
Prof. Farrukh Zia

Amputations can result from traumatic injuries or medical conditions such as congenital defects and diabetes, often leading individuals to rely on prosthetic limbs to restore daily functionality. Prosthetists assist in selecting appropriate devices based on patient needs, with body-powered prosthetic arms being a common solution that utilizes residual muscle movement. More recently, myoelectric prosthetic arms have gained popularity by using surface electromyography (sEMG) to detect electrical signals from muscle activity through non-invasive electrodes. However, these systems are sensitive to environmental factors such as sweat and moisture during prolonged use and are often expensive and bulky. This study proposes a non-invasive alternative that utilizes force-sensing resistors arranged in a matrix configuration to detect pressure from targeted muscle groups. A protective layer is incorporated to improve durability and reliability under extended wear conditions. This approach aims to provide a more affordable, compact, and robust solution for transradial amputees, representing an initial step toward pressure-based prosthetic control systems.

Lead and Heat Vulnerabilities in NYC
Sonya Weinstock
Prof. Anne Leonhardt

This project investigates the spatial distribution of lead exposure and heat variability risks in Brooklyn through geospatial visualization. Using publicly available datasets, the study maps relationships between environmental lead presence, and neighborhood conditions such as socioeconomics factors, demographics, building infrastructure, and heat variations to identify patterns of risk across the city. By analyzing existing data through spatial analysis, the project highlights how environmental hazards are unevenly distributed and often concentrated in vulnerable communities. The work demonstrates how GIS can serve as a tool for identifying urban inequities and informing more equitable design and policy decisions.

Software Integration in Personal Healthcare Devices and the Patient User Experience

Yassine Chahid
Prof. Patrick Slattery

This study investigates the current state and emerging directions of hardware and software integration in medical devices and its implications for patient care. It examines hardware-centric device categories, including implantable therapeutic devices and diagnostic and monitoring equipment used across clinical domains (for example, cardiovascular care), and analyzes the software layers that enable functionality through embedded control, data processing, and clinician- and patient-facing interfaces. Using a structured review of device classes, technical documentation, and published implementation case studies, the study synthesizes how integrated systems support real-time monitoring and clinical decision-making, with attention to usability and workflow friction. It identifies key trends in co-designed hardware and software, including enhanced device functionality, predictive analytics, and adaptive, personalized operation that may improve efficiency and patient outcomes. The study also assesses cross-cutting challenges, particularly data privacy, cybersecurity, and software assurance for safety-critical systems, including tradeoffs between proprietary and open-source components and their governance implications. Finally, it considers how increasing software complexity may influence continuity of care, including potential benefits and risks for discharge planning and post-discharge management.

AI-Driven Risk-Based Authentication for IoT Devices (ESP 32)
Kelsang Sherpa
Prof. Farrukh Zia

This project presents a prototype of a smartphone-free, risk-based continuous authentication system using an ESP32 microcontroller. The system evaluates user context through proximity sensing using an ultrasonic sensor and classifies interactions into different risk levels. In low-risk situations, access is granted automatically, while high-risk scenarios trigger step-up verification using a touch sensor. Visual feedback is provided through an RGB LED. This approach demonstrates how context-aware authentication can reduce cognitive burden while maintaining security for individuals with cognitive disabilities.

AI-Driven Sustainable Textile Waste Utilization in New York State Part II

Kyshia Anderson
Prof. Alyssa Adomaitis

This research addresses the significant and growing problem of textile waste in New York State (NYS). There are critical gaps in literature, as well as effective cross-sector collaboration (fashion, technology, construction) that is necessary for sustainable textile waste solutions. The purpose of this research is to propose a grounded approach that leverages Artificial Intelligence (AI) tools to analyze historical data, forecast disposal trends, and facilitate the prototyping of sustainable building materials for urban development in NYS. Two correlating theoretical frameworks were applied during both parts of the research. During Part I of the study, a Collaborative Human-AI Team (CHAI-t) framework was applied throughout the literature review and context analysis to examine how humans and technology work together. The framework was combined with the Technology Acceptance Model (TAM) to examine findings from the literature review, helping to assess how useful the concept could be if applied within New York City's waste management and construction sectors. This was to establish the current state of practice and identify a crucial reliance on international research for physical material prototyping, thus setting the stage for future applied research. Part II consists of obtaining certification in the CITI Program Human Subject Research (HSR) and the development of an IRB-approved in-depth questionnaire, recruitment, and consent form. Currently, semi-structured interviews with experts in the textile, AI, and construction industries are in process. The questionnaires will provide qualitative data on textile waste, the utilization of AI as a resource, and the feasibility of textile construction materials in preparation for a manuscript.

3D printed Smart Plant Pot
Amber M. Ocasio
Prof. Farrukh Zia

This project will feature a 3D printed plant plot that will automate the plant caring process. This project will resolve the need for plant sitters and allow plant caretakers to monitor the health of their plants through their smartphones. This device will enable users to observe plant data on their smartphones. The device features an ESP32 micro controller to connect to Bluetooth devices, control and collect data from sensors, and feature an automatic watering system. The circuit will include a soil moisture sensor that users can use to analyze the health of the soil. There will be an AC/DC water pump feature that the user can control to water their plant on their smart devices. Data will be stored by connecting an ESP32 to Firebase, which will allow data access to anyone, anywhere, at any time. By combining embedded systems, IoT connectivity, and automated control, this solution reduces the need for manual plant maintenance and provides an accessible, data-driven approach to plant care.

Assistive Devices for Grip Strength

Ugochukwu Emenawu, Amna Saifi
Prof. Farrukh Zia

Arthritis is a common condition that reduces hand strength and mobility, making early detection important for effective management. In this research project, our goal was to make a device that would help us understand the health of a patient with arthritis problems before it gets too serious. We wanted to see how the health of the hands progresses as arthritis starts developing, and at what stage it can still be managed, while making the device at a low cost for hospitals to use. We used a stress ball that was embedded with a force sensor designed to measure the pressure applied during hand grip. We used TinkerCAD to make the design and test how it would simulate and work. We followed it with our prototype. This project combines skills in electrical circuits, computer hardware, software, and technical communication to facilitate the design and development processes. We drew inspiration from tinker making fairies. This approach could provide an accessible tool for early arthritis screening and monitoring.

Architectural Proposals for a Music Museum @ Queensbridge Houses; Focus on Computer Skills and Building Design
Bryant Ariza, Elijah Walker
Prof. Naomi Langer-Voss

From professors and students at CUNY City Tech to NYCHA Design & Implementation specialists and NYCHA residents, ARCscholars encompasses a diverse group of researchers united by the common goal of tackling urban challenges through the research and proposal of enhancements to the built environment. This session students are proposing designs for a Music Center at the NYCHA Queensbridge Houses. Students studied the building typology, researched precedents, developed program diagrams, and learned how to organize the spaces. Simultaneously students are learning AutoCAD and will be using these skills to present their designs.

Assistive Tech Game Controller
Mithila Islam, Mlaikah Noor
Prof. Farrukh Zia

This project focuses on developing an adaptive gaming system tailored for an individual who experienced severe paralysis approximately ten years ago and continues to face significant right-side motor limitations despite partial recovery through physical therapy. Traditional gaming controllers remain difficult to use due to restricted dexterity, and discontinued insurance coverage has limited access to continued rehabilitation, making low-cost assistive solutions critical for maintaining engagement and independence. To address this challenge, a 3D-printed Enabled Controller Mini built around the Adafruit QT Py SAMD21 microcontroller integrated with a joystick and latch switches is programmed and customized via Arduino IDE to match the user's functional abilities, emphasizing left-side mobility while compensating for restricted right-side movement. Performance is evaluated by comparing gameplay accuracy, reaction time, and task completion rates before and after device integration, alongside structured user feedback on comfort and usability. Results aim to show that low-cost, open-source adaptive controllers can significantly improve gaming accessibility for individuals with limited motor ability, offering a reproducible and personalizable framework for broader assistive gaming applications.

GeoPTM: Graph Attention-Based Prediction of Primate Post-Translational Modification Sites via Protein Language Model Embeddings

Christopher Chow, Shiu Wong
Prof. Ahmet Yuksel

Post-translational modifications (PTMs) are critical in regulating protein function and experimental identification of these sites are extremely resource intensive. With the advent of machine learning methods and increased computational power, computational prediction of these sites can offer a solution. However, these methods are challenged by severe class imbalance because the vast majority of amino acids are unmodified. We present a graph neural network-based model for per-residue, multi-class PTM site prediction that combines frozen protein language model features with graph attention learning over local residue neighborhoods. Sequence data was processed as 33-length windows centered on Phosphorylation sites then randomly shifted based on a gaussian distribution with a sigma of 4. Embeddings were extracted using a pretrained ESM2-8M encoder where the 320-dimensional embeddings were used as node features in a static contact graph where each residue connects to 5 sequential neighbors upstream and downstream of the residue of interest. The embeddings were sent through a single GATv2Conv layer with four attention heads, a multi-layer perceptron with layer normalization, GELU activation function, and 0.4 drop out which produced per-residue logits over six output classes corresponding to Phosphorylation, Acetylation, Methylation, O-GlcNAcetylation, and Hydroxylation. Training was supervised by a multi-class focal loss with gamma of 2.5 and optimized with AdamW and an adaptive learning rate scheduler. Additionally, we investigated the effect of window sequence size on model performance by expanding the window size to 63 residues which yielded a class average AUPRC of 0.8411 from 0.7860, a gain of 0.055 points, suggesting that PTM-determining sequences extend beyond close neighboring residues. The results demonstrate that graph attention neural networks used alongside protein language model embeddings provide effective multi-class PTM site prediction without full sequence or multi-dimensional inputs.

Conformal Maps

Marc Verma-Bonany, Serigne Diaw
Prof. Satyanand Singh

Conformal maps are functions that preserve angles and local geometric structure. While they may stretch or compress distances at individual points, they maintain the angles between intersecting curves and thus preserve local shape. In this work, we present some important examples of conformal mapping and explore their key properties. We also discuss a range of applications across diverse fields, including physics, complex analysis, and biology, highlighting how conformal mappings provide powerful tools for modeling and problem-solving in these disciplines.

Determinants of Dental Health Access and Outcomes
Keera Mohammed
Prof. Diana Samaroo

Purpose: This research examines the socioeconomic and environmental determinants of oral health, focusing on how structural factors influence access to care and clinical outcomes.

Methods: A review of existing literature was conducted to identify patterns of dental health disparities related to financial instability, social class, education, and geographic environment.

Findings: The literature reveals a consistent correlation between lower socioeconomic status and increased risks of periodontal disease, untreated decay, and tooth loss. Disparities are driven by systemic barriers, including financial constraints and limited health literacy, rather than individual choices. Notably, family dynamics and maternal behaviors are primary predictors of a child's long-term oral hygiene habits. Despite the presence of developed healthcare systems, immigrants and low-income populations continue to face persistent obstacles that result in unequal health outcomes.

Conclusion: Oral health disparities are rooted in structural inequalities. Addressing these gaps requires comprehensive public health strategies that move beyond individual responsibility to mitigate systemic barriers, improve preventative education, and foster equitable access to dental services across all populations.

Health Equity & Public Health Infrastructure: A State-Level Analysis of Community Health Worker Employment

Ashley William
Prof. Noemí Rodríguez

Community health workers (CHW) serve as culturally competent liaisons who help bridge the gap between foreign-born populations and access to care. The heterogeneity of the U.S. population has important implications for the public health workforce. To effectively allocate resources and promote health equity, it is important to examine the distribution of CHWs in relation to the foreign-born population size by geography. This study examined the relationship between CHW employment and foreign-born populations across the U.S. from November 2021 to May 2024. A descriptive state-level analysis was conducted with MS Excel using the 2024 Bureau of Labor Statistics data on community health worker employment and the American Community Survey 2024 5-Year Estimates data on the foreign-born population by state. The analysis included frequencies for each variable and a spearman-rank correlation with a two-tailed t-test (alpha=0.01). Across the U.S., the average CHW employment was 1,186 workers and the mean foreign-born population was 935,449. California had the highest foreign-born population at 10.5 million and the highest CHW employment at 9,200. Wyoming had the lowest foreign-born population (20,494) while Louisiana had the smallest CHW workforce (60). The spearman-rank correlation coefficient was 0.84 and significant with a p-value less than 0.01 (p=1.86E-14)). The results indicate that states with larger foreign-born populations generally employed higher numbers of CHWs; however, variations across states were present. This suggests CHW employment does not uniformly match the foreign-born population size. Although a significantly positive relationship was observed, the findings do not determine whether CHW employment levels are sufficient to meet the needs of foreign-born populations. Further research is needed to assess workforce adequacy and equity in resource allocation. Furthermore, innovative partnerships between public health departments and states should be explored.

The Effects of Cinnamaldehyde on Tetrahymena thermophila

Sydney Kurland
Prof. Ralph Alcendor

In addition to its common use as spice in cooking and baking, cinnamon has long been used in herbal remedies.[1] Studies looking at potential therapeutic effects of cinnamon and one of its primary components, cinnamaldehyde (CMD), have demonstrated its antioxidant, anti-inflammatory, and antimicrobial properties.[1, 2, 3, 4] Therefore, it is important to study the efficacy, benefits and mechanisms of action of CMD. Although many studies have been done examining the effects of CMD, information on its full potential remains limited.[1, 3] *Tetrahymena thermophila* is a ciliated protozoan commonly used as a model organism in the study of genetics, intracellular processes, and toxicology. [5, 6, 7] As a eukaryote, it shares many biological processes with human cells, making it a valuable system for investigating the effects of CMD.[6] To date, little to no information is available on the effects of CMD on *T. thermophila* . The purpose of this study was to examine the effects of CMD on *T. thermophila* . Because the effects of CMD can be both protective (antioxidant properties) and destructive (antimicrobial properties), it was hypothesized that at lower concentrations, CMD will show a protective effect against oxidative stress and cell death in *T. thermophila* , but at higher concentrations, CMD will have a detrimental effect on *T. thermophila*. To evaluate the effects of CMD on the viability of *T.thermophila* , cells were treated with various concentrations of CMD for 24 - 48 hours, followed by MTT assays and fluorescence-based cell counting of live and dead cells. Results indicated that CMD concentrations of 0.2 mM and greater had a generally detrimental effect on *T. thermophila* survival. Additionally, MTT assays revealed that cells treated with CMD concentrations of 0.01–0.1 mM showed increased viability relative to controls, indicating a potential beneficial effect of CMD within this concentration range, whereas cells treated with CMD concentrations of 0.2 mM and higher showed decreased cell viability relative to controls. Together, these results suggest CMD may have protective effects at low concentrations but exhibit toxic effects on *T. thermophila* at higher concentrations.

Effect of Central Deep Lesions on Intellectual Functioning

Casey Mohabir
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Central Deep cerebrovascular accidents (CVAs) are lesions of the thalamus, basal ganglia, and their proximal white matter. This experiment sought to determine the effects of Central Deep lesions on cognitive functioning. Subjects were patients with either Psychiatric disease (n = 89), or neurologic disease with Central Deep lesions (n = 12) as confirmed by CT or MRI. Cognitive functioning was measured using deviation quotients (DQs) computed from subtests of the Wechsler Adult Intelligence Scale for Verbal-Conceptual (VCDQ), Attention-Concentration (ACDQ), and Perceptual-Constructional (PCDQ) domains. When compared against the Psychiatric group, the Central Deep Lesion group had deficits across all three cognitive domains: Verbal Conceptual Deviation Quotient, $F(1, 95) = 6.19$, $p < .05$, $\eta 2 = .06$; Attention-Concentration Deviation Quotient, $F(1, 94) = 5.44$, $p < .05$, $\eta 2 = .06$; Perceptual-Constructional Deviation Quotient, $F(1, 92) = 7.99$, $p < .01$, $\eta 2 = .08$. The mean DQ decrements were: VCDQ = -10 points; ACDQ = -10 points; PCDQ = -11 points. These results demonstrate that although Central Deep lesions are often of smaller volume than lesions affecting the major cerebral artery distributions, and do not directly impinge upon the cortex, Central Deep Lesions still produce substantial deficits in cognitive functioning.

Tactile Learning Through 3D-printed Assistive Technology

Halima Alazeb
Prof. Farrukh Zia

This project aims at the development of an educational tactile game for visually impaired children aged 4 to 7. It focuses on helping children learn alphabetical signs and symbols through tactile sensation as the main method of learning. The system consists of a board with square compartments and small cubes with textures, raised letters, and Braille symbols. Children interact with the cubes by holding, feeling, rotating, and placing them in the correct slots. Each cube also includes tactile markers to show its correct orientation, with a slightly flattened top and raised edges at the bottom for distinction. The project is currently at the conceptual design stage, supported by drawings and 3D printed prototype ideas.

Cemeteries As Green Infrastructure
Kunchok Norbu
Prof. Jeffrey Keiter

Significance: Earlier research shows the benefits of arboretums, rain-gardens, and beginnings of green infrastructure in large cemeteries (ie. Greenwood cemetery), but the question of how we can utilize excessive stormwater from neighboring highways to create arboretums while still remaining culturally sensitive remains unaddressed. The research is important because it allows for the vast fields and spaces used for the burial of dead bodies to remain purposeful and functional as modern culture and needs evolve. The study will allow for broader possibilities of green infrastructure, minimizing waste and pollution, and improving community space.

Question: In order to achieve arboretum status in NYC, a cemetery must obtain accreditation from the ArbNet Arboretum Accreditation Program by creating an arboretum plan, documenting a collection of at least 25 distinct labeled tree/woody plant species, designating staff, and holding at least one annual public tree-focused educational event. In order for Calvary Cemetery to achieve arboretum status, there would need to be a greater number and variety of trees. The core of this study is to examine Calvary Cemetery as a case study to see how we can create arboretums using stormwater runoff from the BQE and X Highway to improve the quality of life for residents by minimizing pollution, increasing resilience, and increasing greenery.

Methodology: Employing a design approach, we modeled the proposal for an alternative stormwater capture method. Going into the design process, the research involves a detailed examination of the location of stormwater drainage systems and topography using ArcGIS and analysis into social connotations and historical context of utilizing a sacred burial space for stormwater capture.

Conclusions: The study reveals that the cemetery is largely hilly with administration sites at high points. Each bridge is located at ends of the two cemeteries and the stormwater can be redirected to these sites and used as irrigation downstream. In conclusion, it is possible to utilize the excess stormwater runoff from neighboring highways as a water source for the arboretum, and likewise the arboretum serving as a large rain-garden.

Implications: The findings of the research complement earlier studies beginnings on rain gardens/bio swales or irrigation/arboretums in large cemeteries. It invites further exploration into the connection to stormwater runoff from highways, broader scale capture and resiliency, and introducing greenery to improve community health. Following the research, future studies can focus on fine tuning the design of the stormwater drainage from highway to cemetery and within the cemetery for improved functionality.

Implementation of the Automatic Packet Reporting System (APRS) for Emergency Radio Communication

Jaiwei Zhen, Nyran Singh
Prof. Farrukh Zia

This project explores the use of the Automatic Packet Reporting System APRS to support emergency radio communications. APRS is a real-time tactical packet radio system used for sharing position, weather, and status data over a simplex VHF frequency. Typical mobile units, known as trackers, combine a GPS receiver, a TNC modem, and an FM transceiver. These units periodically transmit their coordinates via AX.25 frames at 1200 baud. Digipeaters, which are store-and-forward radios, relay these packets across multiple hops, and IGates forward received packets to the APRS-IS Internet network for visualization on mapping sites such as aprs.fi. Data payloads can include position reports, objects such as points of interest, weather data, telemetry, short text messages, and bulletins, providing a shared situational picture for responders. In disaster scenarios, an RF-only APRS network can deliver near-real-time tracking and messaging even without cellular or internet access. Expected outcomes include improved coordination and enhanced situational awareness among emergency teams.

The Impact of Information Technology on Accounting

Fehaj Pabal
Prof. Elizabeth Milonas

Information technology (IT) has changed accounting in a big way. It helps make work faster, more accurate, and more reliable. This research looks at how IT affects accounting by studying a few academic articles. Today, computers and accounting software are used instead of doing everything by hand. This helps reduce mistakes, process data quickly, and make better decisions using real-time financial information. IT also helps store large amounts of data safely and makes it easy to access when needed. Many businesses now depend on technology to manage their financial records efficiently. However, there are also some challenges, like security risks, high costs, and the need for trained workers. Companies must make sure their systems are secure and their staff are properly trained. Overall, IT is very important in modern accounting and will continue to shape its future.

Gingerbread Architecture Reframed: Design for Use and Construction
Nick Antoine, Anjum Ahmmed, Jennifer Garcia, Brailyn Ventura, Alimary Mejia
Prof. Alexander Aptekar

This research will build on Reinventing Haitian Vernacular with Bio-Based Design. The goal is go more in-depth into structure ,passive building systems, and building assembly. Additionally modularity and rural organization (planning) will be based upon the Haitian "lakou" communal layout, as well as the gingerbread building typology. This in an effort to create buildings that can work in the real world and give the inhabits the opportunity to take part in construction and management, while still honoring tradition. This research aims to create visually appealing design solutions that address local problems such as material scarcity, cost of labor, and structural integrity. Bio based materials will be the primary material selection for designing structural frames. 3D modeling software will be used to model and design these structures. This will be paired with structural calculations and testing to measure structural integrity.

Horror Media Enjoyment: Psychological and Social Perspectives

India Barker
Prof. David Smith

As horror films continue to remain a popular form of entertainment, understanding why individuals are drawn to fear-inducing media has become an important area of psychological research. This study examines the underlying factors that contribute to the enjoyment of horror films, focusing on audience perception, emotional responses, and engagement with fear-based content. The primary research question is: Why do individuals enjoy horror films despite their intention to provoke fear, and how do psychological and social factors influence this experience? Drawing on existing research, as well as survey data and personal testimonials, this study explores concepts such as sensation-seeking, emotional arousal, and the idea of "safe fear," in which individuals experience fear in a controlled environment without real danger. Additionally, theories such as excitation transfer suggest that the relief following fear can enhance positive emotional responses. Findings from survey responses and testimonials indicate that many viewers find horror films exciting, socially engaging, and sometimes even stress-relieving, while others report discomfort or avoidance, highlighting the variability in individual experiences. These results suggest that although psychological theories provide a strong foundation for understanding horror enjoyment, personal differences play a significant role in shaping responses. Future research should expand on these findings by incorporating larger sample sizes and more structured data collection methods to further examine how fear-based entertainment can produce enjoyment and what this reveals about emotional processing.

Cinematic Representation of Mental Illness

Nour Alkhadi
Prof. George Guida

This research examines how mental illness is portrayed in films such as Black Swan, Joker, Manic, and Manchester by the Sea. This topic is significant because films have been around for many decades and is one of a major source of information about mental health for the general public, shaping perceptions and helping viewers build awareness of what mental illness is and how it affects individuals in real life. The central question of this research is how accurately films represent psychological disorders and how these portrayals influence audience understanding. To research this, the study analyzes each film by identifying the mental illness portrayed, examining symptoms and causes, and comparing these depictions to established clinical research. It also considers internal conflicts (self vs. self) and external conflicts (self vs. environment), as well as how realistic or exaggerated each portrayal is. The findings suggest that while some films present more realistic and nuanced portrayals of mental illness, others rely on exaggeration for dramatic effect. These differences can both increase awareness and contribute to misconceptions about psychological disorders. This research highlights the impact of media on public understanding of mental health and suggests that future studies should further explore the relationship between entertainment media and psychological education. It also emphasizes the importance of critically evaluating film portrayals to promote more accurate and informed perspectives on mental illness.

AI Cybersecurity Skills Gap: Aligning Higher Education Curricula with Workforce and Employer Expectations

Jabber Bin Kibria
Prof. Patrick Slattery

The fast growth of artificial intelligence (AI) and cybersecurity has created new challenges, especially when it comes to preparing students for real-world jobs. Even though there is a high demand for cybersecurity professionals, there is still a noticeable gap between what students learn in college and what employers are looking for. This gap becomes even more important as AI continues to change the skills needed in the field. This research looks at the skills gap between AI and cybersecurity by examining job postings, certification requirements, and the current cybersecurity curricula used in colleges and universities. The goal is to understand where academic programs fall short and how employer expectations differ, especially in areas influenced by AI. The main objective of this study is to find ways to better connect education with industry needs. It aims to suggest improvements to cybersecurity curricula so that students can be more prepared for real-world roles after graduation.

MediTrack – Medication Scheduling & Tracking Application
Nadia Khan
Prof. Farrukh Zia

Earlier research shows that medication non-adherence remains a widespread public health challenge, but the question of how individuals can reliably self-manage complex medication schedules in daily life remains unaddressed. The research is important because it contributes to a broader understanding of technology-assisted patient self-care. The core of this study is to examine how a mobile application can effectively support users in tracking, managing, and adhering to their personal medication regimens. Employing a full-stack application development approach, the research involves a detailed analysis and implementation of a cross-platform mobile system using Expo React Native on the client side and a Node.js/Express REST API backed by an SQLite database on the server side. The study reveals that a structured digital tool featuring user authentication, daily dose checklists, medication CRUD management, and dose history logging meaningfully reduces the cognitive burden of medication tracking. These findings suggest that lightweight, locally deployable mobile solutions can match user needs effectively, offering a new perspective on accessible personal health management. The findings of this research complement earlier studies on digital health interventions by demonstrating a practical, low-infrastructure implementation. It invites further exploration into notification-driven adherence reminders and caregiver-sharing features. Following this research, future studies can focus on integrating clinical data exports and evaluating long-term adherence outcomes among chronic illness patients.

Cryptocurrency Price Prediction using Machine Learning
Amadou Diallo
Prof. Marcos Pinto

Students collect historical cryptocurrency price data (e.g., Bitcoin, Ethereum) and other relevant factors (e.g., social media sentiment, trading volumes). Data has to be preprocessed (cleaned) and we need to build ML models (e.g., LSTM, ARIMA, regression) to predict future prices. The project can include a simple trading bot that uses the predictions to simulate buying/selling. This project benefits the student who gains hands-on experience with skills that transfer directly to data science, finance, and software engineering.

Detecting Illicit Bitcoin Transactions: A Comparative Analysis of Graph Neural Networks and Traditional Machine Learning

Derrick Keith Jr.
Prof. Marcos Pinto

The problem of crypto mixing has been around since the early years of cryptocurrencies. Crypto mixing is the process of obscuring the digital footprint of transactions on the blockchain which in turn makes money laundering difficult to detect. Traditional methods used to detect an address used for crypto mixing often struggle at graph scale. This research aims to compare graph-based machine learning models (GCN, GAT, Random Forest, and Hybrid GAT +RF) against traditional methods for detecting illicit Bitcoin transactions. Two different datasets were used with different levels of feature engineering: an Elliptic dataset (166 pre-engineered features with a size of 203,769 nodes and 234,355 edges) and a BitcoinHeist dataset (6 raw features and 49,830 transactions) both sourced from Kaggle. PyTorch Geometric was used for building the GCN and GAT layers and handling most of the graph functionality, SciKit-Learn was used to handle the Random Forest model. On the Elliptic dataset, Random Forest led with the highest F1 score of .810, outperforming the three other graph-based models, GCN scored .648, GAT scored .581, and the Hybrid (GAT + RF) was at .662, showing that the traditional model performs well when features are pre-engineered. On the BitcoinHeist dataset, the Hybrid model won, achieving the top F1 score of .691. The Random Forest model came right before at .550, GAT at .472, and GCN at .369. In conclusion, traditional models seem to have the upper hand with feature rich data and fall behind when features are lacking allowing for graph-based machine learning models to obtain more effective results. There is not a single “one-size-fits-all” model that dominates across datasets.

Secure Federated Learning for Financial Fraud Detection

Adam Rouzaqui
Prof. Marcos Pinto

As financial fraud becomes increasingly sophisticated and cross-institutional, traditional centralized machine learning (ML) models face a critical "silo" problem: individual banks cannot share sensitive customer data due to strict privacy regulations — including GDPR and CCPA — as well as significant competitive risks. This project proposes a Secure Federated Learning (FL) framework that enables multiple financial institutions to collaboratively train a robust fraud detection model without ever exchanging raw transaction data. By keeping data localized and sharing only encrypted model updates, this approach ensures strong data privacy while simultaneously improving detection accuracy across the entire network of participating institutions. The framework addresses the fundamental tension between regulatory compliance and the need for collective intelligence in fraud prevention — enabling collaboration where it was previously impossible. Ultimately, this research aims to demonstrate how Federated Learning can overcome deep-rooted institutional barriers, providing a scalable, privacy-preserving, and secure solution for the financial sector to detect and prevent collaborative fraud at scale — advancing both the state of applied machine learning and real-world financial security.

Does X-ray scattering always decrease structural details: why the rule does not apply to low-density samples

Natalya Tomskikh, Joseph Laguerre, Jaskaran Singh, Al Emran
Prof. Subhendra Sarkar, Prof. Eric Lobel

Scattered components in X-ray imaging is typically regarded as a cause for degrading images and obscuring structural detail in radiographic analysis. However, in low–atomic-weight, low-density materials such as foams, polymers, agricultural produce, etc. scattering is negligible and is overlooked. In the current project, X-ray images of several soft materials were obtained after modifying the incident X-ray beam. The goal was to enhance and control the X-ray scatter and was analyzed to determine whether the radiographic noise has any useful sample related pattern or information. Foams with coarse or fine pore structures and starch papers with were selected due to their fiber-like and porous structure that resemble human tissue and may provide information about microstructure of internal defects or pore surfaces. Within the samples investigated, low-energy Compton-type scattering and the Auger effect from primary beam seem to generate secondary X-rays. Region-of-interest (ROI) analyses of thin-walled plastics and porous foams showed changes in the intensity and homogeneity of transmitted beams. Instead of predictable photon loss as in hard materials, soft materials often showed increases in both the intensity and the heterogeneity of photon flux, particularly at soft materials interfaces. X-ray physics of soft materials is underdeveloped and inadequate for low–atomic-weight, low-density materials imaging. On the other hand, radiation-free diagnostic procedures like MRI for soft materials work very differently than X-rays but are prone to magnet safety risks and artifacts. Our work exploits the complementary nature of these two methods and demonstrates medical and agricultural applications.

WiFi Sensing Application in Healthcare System

Yuzhen Chen
Prof. Fangyang Shen

This study examines the revolutionary transition from conventional cameras to ubiquitous WiFi routers for non-invasive human monitoring in fitness and healthcare. The device, also known as WiFi Sensing, employs artificial intelligence (AI) techniques to decipher minute disturbances in WiFi signals, or Channel State Information (CSI), which are specifically dispersed by the human body. WiFi sensing provides a discreet, affordable, and all-inclusive substitute for current sensors because these signals may go through walls and function in the dark. Important discoveries show that the system can reliably identify a person's presence, gestures, and vital indications like breathing rate.

Non-invasive characterization of biometal transport in porous carbohydrates after induction of stress

Zeenia Ahmed, Siham Benabou, Hailah Nagi Jr, Ali Algemsh, Feldy Liriano
Prof. Subhendra Sarkar, Prof. Evans Lespinasse

In this project we developed non-invasive characterization using very low-energy secondary X-rays in low-density porous materials and their relationship to metal accumulation of biological systems. Using apples as a model system, we investigated how mechanical stress, like head trauma, and bacterial stress influence internal structure and the redistribution of bio-metals. Since metal accumulation plays a key role in both tissue response and material behavior, this study aims to better understand how these changes occur under different stress conditions relevant to medical and agricultural applications.

X-ray and MRI imaging are used as complementary techniques to study these effects, as both methods detect metal accumulation using different physical principles. X-ray imaging detects metals based on density differences, while MRI detects metals through magnetic properties. MRI is sensitive to certain metals such as iron, calcium, and manganese even at very low concentrations, but cannot reliably detect others such as copper, zinc, or magnesium, which are also important in living tissue. In contrast, X-ray requires higher concentrations for detection but provides unambiguous structural information. On the other hand we observed MRI results create ambiguity due to metal-like signal behavior from other sources. Therefore, both imaging methods were used for concordance and compare results. We believe this work could lead to further imaging methods for low atomic-weight soft-materials, agricultural produce quality management, and targeted soft-tissue tumor characterization.