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Plant's Coping Mechanism With Damaged DNA

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Prof. Eric Lobel

This literature review examines the effects of DNA damage in plants caused by radiation sources such as UV light, ionizing radiation, and chemical mutagens. Because unrepaired DNA damage can lead to a range of consequences — from impaired cellular function to cell death — affected plants may fail to develop normally or may wither. This review outlines the mechanisms by which DNA damage occurs and the repair pathways plants employ to respond to and recover from that damage.

Applications of the Quantum Zeno Effect

By 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.

Pupil response to facial and anatomical images

Jazmine Martin, Cassara Norville, and Casey Mohabir
Prof. Daniel Capruso

This experiment sought to determine if there are gender differences in pupillary reactivity during an exposure to an anatomical image. Subjects were CityTech students (n = 21). Foveal fixations were recorded with a Tobii T-60 eye tracker with a temporal resolution of 60 Hz and a typical gaze position accuracy of 0.5° of visual angle. The stimulus image was “Nothing Hurts” (Stephen Mackey), a gothic and quasi-realistic figurative painting of a young female performing an abdominal vivisection on herself. For the facial area of interest (AOI), pupil diameter of Males (n = 11) on initiation of gaze (M = 4.66, SD = 0.64) and on termination of gaze (M = 4.44, SD = 0.55), was larger than for Females (n = 10) on both initiation of gaze (M = 4.39, SD = 0.64) and on termination of gaze (M = 4.16, SD = 0.54). A main effect was present for Time, F(1, 19) = 9.56, p < .01, but not for Gender, F(1, 19) = 1.21, not significant, and there was no interaction. For the viscera AOI, pupil diameter of Males on initiation of gaze (M = 4.79, SD = 0.52) and on termination of gaze (M = 4.46, SD = 0.45), was larger than for Females on both initiation of gaze (M = 4.21, SD = 0.29) and on termination of gaze (M = 4.13, SD = 0.594). Main effects were present for both Time, F(1, 19) = 5.41, p<.05, and for Gender, F(1, 19) = 5.76, p < .05, but there was no interaction. The results indicate that Males showed greater visual interest that Females in both the facial and visceral aspects of the vivisection image, but that only the Females showed a sustained interest in the face over time. The results are consistent with the generally accepted finding that females have a greater attention and perceptual sensitivity toward facial emotional cues than do males.

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 & 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.

Role of Artificial Intelligence in Radiology Practice

Forruk Ahmed, Anna Aleskyeyeva, Oman Balan, Ashley Hassang
Prof. Zoya Vinokur

The use of artificial intelligence is growing in the field of radiology, changing the way medical images are being read and interpreted. These changes affect how clinical workflows are managed including prioritizing urgent cases, reducing radiologist workload, and speeding up image analysis. This paper examines the impact artificial intelligence has on these workflows and whether AI has the capability to improve the detection of abnormalities that may be missed by radiologists, reduce workload, and improve image analysis. Existing studies show that the significance of AI depends on factors such as the level of trust in AI, the human AI interaction, and the experience of the clinician. This study analyzes these criteria and has found that reliance on AI introduces risks such as automation bias, reduced attentiveness and complacency. Findings across different studies show that AI produces false positives and false negatives and requires supervision by an experienced radiologist. Overall, most cases agree that AI works best as an augmentative tool for radiologists, improving speed and consistency while the radiologists apply their clinical judgement and context for final interpretation.

Frameworks For Data Visualization

Kazi Tamim Nomany, Kazi Rahimu Islam
Prof. Patrick Slattery

Data visualization is essential for transforming complex datasets into formats that enable accurate interpretation, analysis, and communication. As data continues to play an increasingly important role in research, business, policy, and everyday decision making, the need to present information clearly and effectively has grown in significance. This research develops a structured framework for selecting visualization methods based on data characteristics, analytical objectives, and audience needs.The study examines how different chart types communicate key analytical patterns, including trends over time, comparisons across categories, distributions within datasets, and relationships among variables. It also evaluates how design elements such as scale, labeling, color use, emphasis, and visual hierarchy shape interpretation and influence a viewer's ability to extract meaningful insights. Drawing on established visualization theory and practical examples, the research emphasizes that effective visuals must be accurate and informative while also being clear, accessible, and inclusive, particularly given that an estimated 1.3 billion people worldwide live with significant disability. The goal is to identify visualization strategies that are reliable, meaningful, and appropriately aligned with the insights they are intended to communicate.

BABS Stage 1: Arc 2
Francky Duperval
Prof. David Smith

The plan for Arc 2 is to create a compact sensor device utilizing Optical PPG-Based Detection through a Pulse sensor for Arduino. The device will be capable of capturing heartbeat from its user, and converting it to a clean digital pulse capable of assigned event triggering, resulting in audio and visuals. These mappings should remain external to the pulse-conversion core, which will preserve reusability and allow the same heartbeat event stream to participate in different experimental mediation pathways. The device will also be capable of interfacing with the main BABS system. This issue will be tackled once there is verification that the system is functional. A report will also be generated on system reliability, including its ability to capture every heartbeat, its lack of false positive triggers, low and stable latency. Multiple rounds of testing will be done. First to confirm that the waveform is detectable and stable under quiet stationary conditions. Then, to measure whether exactly one digital pulse is emitted per beat under controlled conditions. Next, to vary the lockout interval to determine the best balance between duplicate suppression and missed beats. Then there will be repeat tests during mild body movement to determine if the sensor approach remains usable. Afterwards, the delay between signal event and digital pulse output will be measured using logging or test instrumentation. Finally, the emitted pulse will be used to trigger a downstream event such as a light flash, software event message, or simple media cue. To test system reliability we will measure, if every heartbeat is captured, are there false positives, and the latency. For system latency in particular, we will directly record the heartbeat and compare it to the signal arrival. When interfacing with Jitter, we will test if the latency remains stable if it deviates from beat to beat. The anticipated findings are a visually detectable beat, the capture of every heartbeat, a slow false trigger rate, a low trigger latency, a low and/or manageable setup burden, acceptable user comfort, straightforward hardware, a minimal output mode of one digital pulse per validated beat, and a usable pulse signal that can trigger downstream events.

Assistive Technology in Health & Fitness for Disabled Individuals

Zelea Hall
Prof. Farrukh Zia

In recent decades, the United States has experienced an increased interest directed toward holistic health, which highlights the well-being of every facet of what makes a person whole and complete addressing their entirety. The four dimensions necessary for optimal health include physical, mental, social, and more recently incorporated spirituality. More than 1 in 4 adults (28.7%) in the US are living with a disability with mobility ranking the highest. Despite research and medical professionals emphasizing the importance of an active lifestyle and preventative care physical activity continues to steadily decline. The recommended levels of physical activity are linked to a lower risk of numerous preventable health conditions including chronic illnesses, depression, anxiety and even Post-Traumatic Stress Disorder (PTSD). However, individuals living with one or more disabilities engage in significantly less physical activity and will experience higher rates of mental health disorders compared to the average healthy individual. In collaboration with City Tech Computer Engineering Department, this project aims to design and 3D print customized assistive devices to enhance mobility for individuals with disabilities, ultimately supporting their physical and holistic well-being. This research will be conducted using a qualitative approach by open ended survey questions.

Heteromorphic robot
William Morales
Prof. Xiaohai Li

We have successfully 3D modeled and printed parts for the robot and successfully tested the motors for basic function . After building the physical body of our transforming robot, Phase II focuses on upgrading its "brain" and testing its real-world limits. To handle the complicated movements of transforming, we are switching from the basic factory software to a custom-programmed ESP32 microcontroller. To make this work, we first have to build a custom hardware bridge so this new brain can properly communicate with the motors. Next, we are running physical stress tests to see how strong the motors and 3D-printed parts actually are under the robot's full weight. By measuring the robot's realistic lifting power, heat limits, and how much the plastic bends under pressure, we can write feasible and robust code. Using this real-world data prevents the robot from breaking its own parts and ensures it transforms smoothly and safely between a car and a humanoid.

Chest X-Rays as a Window to Osteoporosis Risk

Shauyen Ng Mei, Joel Perez
Prof. Eric Lobel

Earlier research shows that osteoporosis screening relies mainly on dual-energy x-ray absorptiometry (DXA), but the question remains whether routine chest radiographs can detect patients at risk before they meet standard screening criteria. The core of this study is to examine the beneficial use of chest x-rays for identifying signs of bone demineralization in adults ages 50 to 65. Employing a cross-sectional review approach, the research involves a detailed analysis of 390 emergency department chest x-rays by comparing the original radiology reports with an independent radiologist's review. The study reveals that bone demineralization was only documented in 1.0% of the original reports, whereas independent reviews identified low bone density in 12.6% of cases. Findings of the research support earlier studies emphasizing the value of incidental findings in medical imaging, inviting further discussion on how chest radiographs may be used to detect early osteoporosis risk diagnosis and recommendation for additional screening.

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.

NASA Agriculture Cultivation on Mars Utilizing PEGDA Hydrogels

Elva Zhang
Prof. Ozlem Yasar

The purpose of this study is to investigate how to provide life support to astronauts for long-term space expeditions. Due to Mars' cold, dry environment and toxic soil saturated with perchlorates, space agriculture poses a challenge for providing sustenance to astronauts. Polyethylene Glycol Diacrylate (PEGDA) is a biocompatible polymer that can form versatile hydrogels. The hydrophilic properties of PEGDA allow plants to germinate without the use of Martian soil. Arugula seeds were selected for the initial stages of the project due to their fast growth cycle. Using 3D printing techniques, the current priority of this project is to create a Y-shaped mold to hold the seed in place while it germinates. Environmental factors will continue to be introduced to replicate the Martian environment and improve moisture retention, antibacterial properties, as well as other qualities that will lead to successful germination.