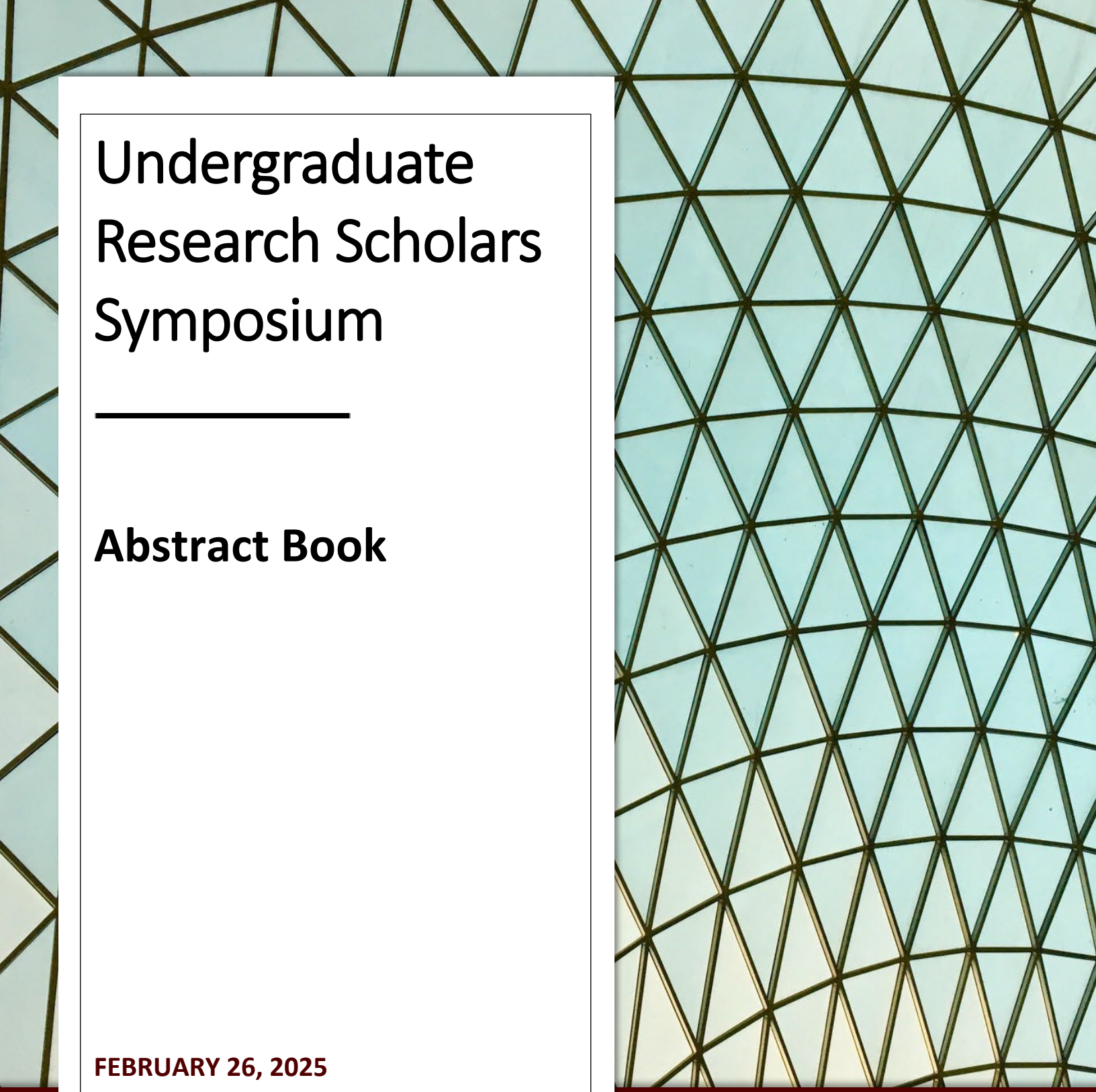

Undergraduate Research Scholars Symposium

Abstract Book

FEBRUARY 26, 2025

Texas A&M University

Undergraduate Research
DIVISION OF ACADEMIC AFFAIRS

About the URS Symposium

The Undergraduate Research Scholars (URS) Symposium showcases undergraduate researchers in the Undergraduate Research Scholars thesis program. The URS thesis program provides undergraduates with a graduate student experience by allowing them to participate in research, produce a professional document, and communicate their findings as principal authors to the University's scholarly community. Learn more about the URS thesis program at https://tx.ag/URSthesis.

The URS Symposium is free and open to the public. Faculty, staff, post-doctoral and graduate students, as well as undergraduate students from all disciplines are encouraged to visit the URS Symposium to learn about numerous research projects being conducted on campus by undergraduates and discover ways to get involved in research at Texas A&M University.

URS Symposium Schedule

Free & Open to the Public | Bethancourt Ballrooms (MSC 2300 A-E)

https://tx.ag/URSsymposium

Oral Sessions

Session 1		9:00 AM-10:15 AM		MSC 2300 B and D
Session 2		10:30 AM-11:45 AM		MSC 2300 B, D, and E
Session 3		12:15 PM-1:30 PM		MSC 2300 B and D
Session 4		1:45 PM-3:00 PM		MSC 2300 B, D, and E
Session 5		3:15 PM-4:30 PM		MSC 2300 B, D, and E

Poster Sessions

Session 1		9:30 AM-10:30 AM		MSC 2300 C
Session 2		11:00 AM-12:00 PM		MSC 2300 C
Session 3		1:00 PM-2:00 PM		MSC 2300 C
Session 4		2:30 PM-3:30 PM		MSC 2300 C
Session 5		3:30 PM-4:30 PM		MSC 2300 C

Contents

Oral Sessions

Oral Session 1: 9:00-10:15 AM

Room: MSC 2300 B

Userspace Memory Remapping Interfaces for Linux

Alex Beamer

Faculty Advisor(s): Dr. Dmitri Loguinov

Streaming data and larger-than-RAM processing are becoming increasingly important as we move to the cloud and to distributed models of data management. When dealing with big data, the performance of analysis systems can have wide-reaching impacts on the design of an organization's hardware and software design. Current research pursues fluid memory as a way to write programs that deal with streaming data at speeds that are closer to modern hardware. This paper presents a novel userspace API for performing remapping of physical memory into virtual memory to support high performance streaming data processing. This API relies on its low-level interactions with data structures used by the kernel and the CPU to achieve this speed, resulting in a tradeoff against portability and security. For applications operating in a trusted environment, this system presents the possibility of a 200 times increase in remapping speed over traditional kernel APIs present in Windows, and extends the functionality into the Linux ecosystem.

Kv7 Channel Expression in Large Coronary Arteries based on Hypoxic Insult

Suyin Tae Woo

Faculty Advisor(s): Dr. Christine Heaps

Hypoxia is a key condition to ischemia, the primary driver of heart disease. A reduction in oxygen tension induces changes within endothelial cells in arteries. Kv7 channels are key modules in arteriolar vasodilation, though the expression of this specific channel has not been compared in different artery sizes. The endothelium is responsible for releasing endothelial hyperpolarizing factors (EDHFs), which may contribute to the kv7 channel activation in the smooth muscle. As a result, research on H2O2 levels affecting cells as a possible EDHF contributor has been proposed as a preliminary testing mechanism that supports endothelium kv7 activation in large arteries. Using the clinically relevant swine model for the current study, we isolate a reduction in oxygen tension, ex vivo, as a single characteristic of ischemic heart disease to test the hypoxic impact on the severity of endothelial cell damage. Current data is inconclusive to show Kv7 channel expression, but we have demonstrated hypoxic insult to endothelial cells in both isolated coronary arteries and arterioles.

Modeling Molecule Diffusion Through a Hydrogel-based Multi-analyte Biosensor

Lainey Streetman

Faculty Advisor(s): Dr. Michael J. McShane

A continuous monitoring system for patients with chronic diseases would have a major impact on the management of the disease; a common example is the widespread availability of continuous glucose monitors. However, current devices are limited to tracking a single biomarker. The next major stride in chronic disease management is the development of an implantable multi-analyte biosensor that would provide more holistic monitoring of a patient's metabolic state. This biosensor would provide continuous monitoring of multiple biomarkers. As far as the author knows, there are currently no multi-analyte implantable devices available on the market. This project addresses this unmet need by using computational modeling to optimize the design of a multi-analyte biosensor. This project uses computational fluid dynamics to simulate the diffusion of oxygen and glucose through a hydrogel-based multi-analyte biosensor implanted in subcutaneous tissue. It focuses on poly(ethylene glycol) diacrylate (PEGDA) as the hydrogel matrix and generates data on how different molecules diffuse through the sensor. First, diffusion through the sensor alone is studied. Then, the model explores the sensor's reaction to the body's immune system, simulating diffusion through inflamed tissue and encapsulation from the foreign body reaction (FBR). If successful, this study will provide data on a multi-analyte biosensor to aid in its design.

Exploring the Sensorimotor Roots of Meaning Using Deep Learning

Arjun Madana

Faculty Advisor(s): Dr. Yoonsuck Choe

To “understand” is to connect past experiences to novel sensory inputs and produce an action output that furthers progress towards the goals of an agent. Current autonomous agents lack understanding, which hampers their ability to perform well in tasks outside of a specific specialty. To equip an autonomous agent with the ability to understand, the agent must adapt to new environments and stimuli while connecting these inputs to its own actions, which are based on motor primitives. Motor primitives are the elementary motor actions that serve as building blocks for more complex movements and movement patterns. These motor primitives shape an agent's ability to interact with and navigate through its environment. In biological systems, visual inputs are processed through receptive fields, which are then decoded through motor primitives. Receptive fields and motor primitives co-develop, which ensures the agent can build knowledge of its own capabilities and contextualize them within its environment. In digital agents, one of the methods by which this linkage can be achieved is through reinforcement learning, which ensures that the agent will iteratively improve its level of understanding. We hypothesize that an agent with inadequate motor primitives will not be able to thoroughly comprehend its environment. We aim to modify an existing sensorimotor model's motor primitives to test the impact this creates on an agent's performance in a motor primitive-based task. Our findings indicate that insufficient primitives can hamper an agent's ability to learn the environment and decode

its own sensory states. The results of this paper could be applied in fields such as robotics, controls, navigation, and others involving autonomous agents to increase agent accuracy and adaptability.

Room: MSC 2300 D

The Good Samaritan Thesis: A Case Study in Hybrid Deontological and Consequentialist Moral Theories

Ana Vergara Gonzalez

Faculty Advisor(s): Dr. Dwayne Raymond

The Good Samaritan Thesis (GST) maintains that abortion is immoral only if it violates the positive duty to something–to give aid to another. As such, discussions of the GST focus on whether or not abortion violates a positive duty to aid. This focus differs from a traditional view which emphasizes a negative duty of non-interference. In her book, Arguments about abortion: Personhood, morality, and law (2017) Kate Greasley develops a case against the GST by maintaining two points: 1) aborting the fetus is not an omission but a failure to save the fetus 2) abortion is an act of killing. Her discussion centers on various medical practices where she maintains that these practices involve direct killing and not simply a failure to save the fetus. In this presentation I will investigate Greasleys arguments. I will show that Greasley's discussion of the pre-viable fetus entails a stronger right that she acknowledges. Instead of the right to life involving obligations of non-interference, Greasley's discussion requires that there exists a positive duty to assist a pre-viable fetus to live. I will show that this duty to assist the fetus to live stronger than the duty of rescue nor is it the same as non-interference. Such an obligation may exist, but it violates the foundational assumption with which she began; that the fetus and the mother have the same right to life.

The Impact of Chaplains on Soldiers in the Civil War

Mario Martinez Alfaro

Faculty Advisor(s): Dr. Ira Dworkin

This paper examines the crucial role of chaplains in providing spiritual and emotional support to soldiers during the American Civil War, highlighting their significant influence on morale, unity, and resilience. The narrative begins with a poignant moment for the Irish Brigade, as they engage in a solemn absolution at the Battle of Gettysburg, setting a powerful tone for the discussion of chaplains' contributions, Chaplains like Reverend William Crosby, Charles T. Quintard, and John B. Bannon became essential figures both on and off the battlefield. By offering prayers, sermons, personal counsel, and sacraments, these chaplains addressed the spiritual needs of soldiers while fostering trust and camaraderie amid the chaos of war. The paper also explores the experiences of soldiers who interacted with their chaplains throughout the harrowing journey of service. Through the soldiers' perspectives, chaplains are portrayed as indispensable anchors both in the heat of battle and in the quieter, reflective

moments that punctuate their harrowing days. They rise to meet the overwhelming challenges of war, offering not just solace but a sense of purpose and belonging. These chaplains emerge as indispensable figures, both in the heat of battle and in the quieter moments of reflection. In every prayer they utter, every sermon they deliver, and every private conversation they share, these chaplains illuminate the path to hope and resilience. They cultivate an environment of trust and camaraderie among the troops, serving as beacons of hope and solidarity amidst the chaos and fear that permeate the battlefield. Through their unwavering presence, they remind soldiers of their shared humanity and the sacred values for which they fight, helping them navigate the shadows cast by war.

Application of Exogenous Sterols for the Reduction of Growth in Arabidopsis thaliana

Jake Fields

Faculty Advisor(s): Dr. Larry Griffing

The combination of an ever-increasing global population and the threat of reduced future crop yields due to climate change calls for new technologies to support the cultivation of staple food crops. One avenue for improving crop yields is the employment of herbicides to restrict the growth of undesirable competing vegetation. Sterols play a vital role in the growth and development of plants, but it has been shown that introducing an excessive amount of plant sterols to Arabidopsis thaliana during growth leads to an overall reduction in biomass. It is thus conceivable to develop an herbicide from plant sterols that would also prove nontoxic to human consumers. This research examines how three different sterols, cholesterol, stigmasterol, and beta-sitosterol, impacted the growth of Arabidopsis thaliana when applied exogenously, as well as how the amount of sterols produced by the plant itself was altered. A fluorometric assay is being performed to measure the amount of sterols extracted from seven day old plants that are grown on media containing varying types and concentrations of sterols. If the trends in sterol content per gram of harvested plant matter differ despite the consistent decrease in overall growth, the mechanisms by which each sterol affects plant growth may be different. Comparing how different sterols applied during growth alter the overall sterol production in plants could lead to further research to understand the specific cellular and molecular mechanisms involved in the reduction of growth and thus the ability to fine tune a developing herbicide to greater effect.

Oral Session 2: 10:30-11:45 AM

Room: MSC 2300 B

How Does Morality Exist? Examining Moral Anti-Realism and Humean Constructivism in Metaethics

River Scott

Faculty Advisor(s): Dr. Linda Radzik

Is something 'Good' or 'Bad' merely because we think it is? Are some things 'Good' or 'Bad' independently of how we feel about them? In other words, do moral values exist as mind-dependent or mind-independent entities? Are some moral rules universal among all rational agents? The field of metaethics in philosophy attempts to answer these questions, among others, and this presentation will explore the question: How does morality exist? The distinction between moral realism and moral anti-realism will be explored. The distinction between two prominent versions of antirealism, Kantian constructivism and Humean constructivism, will also briefly be presented.

Examining the History of Public Housing, the Housing Choice Voucher Program, and the Potential Impact of the Homes Act

Rory Gremillion

Faculty Advisor(s): Dr. Shannon Van Zandt

Around 3.5 million low-income households are currently housed through public housing and the Housing Choice Voucher (HCV) program. These programs have played a crucial role in providing rental assistance to vulnerable populations. However, due to insufficient funding, limited political support, and historically differing ideologies about the role of government in housing, three-quarters of households that qualify for rental assistance do not receive it. This lack of access leaves millions of families struggling with rent burdens, housing instability, and substandard living conditions. This study synthesizes prior research and examines the historical evolution of public and assisted housing to assess its successes and failures. By understanding the policy decisions and program designs that have shaped these initiatives, the study identifies key factors that have hindered or supported their effectiveness. The analysis also examines external pressures, such as push back from the private market and changing federal priorities, which have impacted the programs. Building on this analysis, the study compares these historical findings to the Homes Act, a new legislative proposal currently under consideration. The Homes Act seeks to address many of the shortcomings of past efforts by expanding funding, enhancing program flexibility, and improving access for underserved populations. These insights provide a roadmap for policymakers to tackle persistent issues and explore actionable solutions to improve housing outcomes for the nation's most vulnerable families.

Discrete Graph Diffusion for Mass Spectrometry Structural Elucidation

Montgomery Bohde

Faculty Advisor(s): Dr. Shuiwang Ji

Mass spectra are profiles of molecules that play a fundamental role in elucidating the structures of unknown metabolites as they provide significant information about the structure of a molecule while being sufficiently fast and cheap for high-throughput screening. However, current computational methods for mass spectrometry structural elucidation are unable to accurately match unknown spectra to molecular structures. Additionally, current computational and machine learning approaches rely on external retrieval databases, thus limiting the ability to annotate previously unseen molecules. Towards high-throughput, automatic scientific discovery of small molecules, we present DiffMS, a formula-constrained encoder-decoder architecture that performs conditional molecular generation from mass spectra. The encoder utilizes a transformer architecture and models mass spectra domain knowledge such as peak formulae and neutral losses, and the decoder is a discrete graph diffusion constrained on the chemical formula. To train a decoder that better bridges structural profiles and molecular structures, we pretrain the diffusion decoder with fingerprint-structure pairs, which are of magnitudes larger in size than spectrum-structure pairs. Extensive experiments on CANOPUS and MassSpecGym benchmarks show that DiffMS significantly outperforms all existing models for de novo molecule generation. We further provide several ablation studies to demonstrate the effectiveness of our pretraining-finetuning approach. Finally, we show impressive performance scaling with increasing pretraining dataset size, thus providing an avenue for future works to continue to improve the performance of our approach by building larger and more chemically comprehensive pretraining datasets.

Degrees of Change: Influencing the Perceived Knowledge, Attitudes, & Behavioral Intentions of Natural Resource College Students & Young Professionals Through an Applied-Learning Curriculum

Caitlin M. Castro

Faculty Advisor(s): Dr. Elizabeth Silvy, Dr. David Matarrita-Cascante

While research indicates that education can temporarily alter environmentally positive behaviors, few studies assess the long-term impact of intrinsic characteristics of a natural resource management curriculum.This study aims to explore the role of an applied and experiential learning-focused curriculum in promoting pro-environmental knowledge, attitudes, and behavioral intentions among college students towards environmental management and individual behaviors. To achieve this goal, the study will collect data from students in the Texas A&M University Department of Rangeland, Wildlife, and Fisheries Management (RWFM) senior seminar students and recent graduates. Participants complete a three-part quantitative survey, rating statements on a Likert scale regarding their perceived knowledge, attitudes, and behaviors towards natural resource management and pro-environmental practices before and after the program. With consent, follow-up qualitative interviews are conducted to expand on survey responses. Preliminary findings suggest that experiential learning and applied activities are viewed by students as key factors in fostering pro-environmental attitudes and enhancing

their perceived knowledge, attitudes, and behavioral intentions towards natural resource management and personal behaviors. These results support our hypothesis that experiential learning and applied activities are identified by students as the most influential in the development of pro-environmental attitudes, behavioral intentions and a positive change in knowledge, attitudes, and behavioral intentions towards natural resource stewardship. The goal for this project is to inform environmental curriculum advancement to best equip future professionals and connect people with nature.

Room: MSC 2300 D

Effects of Glycosylation on Solvation and Binding of CD2 and CD58

Oluwajomiloju Olufemi

Faculty Advisor(s): Dr. Wonmuk Hwang

Immune cell recognition is a complex process involving many biochemical and protein mediated cell-to-cell interactions. Understanding the individual elements of this process is integral for developing therapies that either supercharge the immune system against elusive threats or selectively suppress the immune response in autoimmune diseases. This study focuses on CD2 and CD58, glycoproteins involved in the cell adhesion process of immune recognition, and aims to understand the binding dynamics of these proteins in their glycosylated state by studying protein-water molecule interactions and the overall hydration environment. The rapid, low affinity binding between CD2 and CD58 allows T cells to stably move along the surface of antigen presenting cells before anchoring and activation. This makes these proteins prime targets for potential modulation of the immune response given sufficient molecular understanding of their interactions. Molecular dynamics simulation gives the necessary level of detail to monitor water molecule interactions with the bound and unbound proteins. Despite the known importance of glycosylation to the binding of this system, previous experimental studies were unable to study the proteins in their glycosylated state due to issues in the synthesis process. To understand the role of glycans in this system, this study also compares the binding dynamics and hydration environment between glycosylated and non-glycosylated CD2 and CD58.

Investigating Changes in Acetylcholine Nicotinic Receptor Subunit β2 in the Adult Mouse Brain Following Prenatal Alcohol Exposure

Tia Pandey

Faculty Advisor(s): Dr. Rajesh C. Miranda, Dr. Siara K. Rouzer

Background: Established research demonstrated that alcohol can alter acetylcholine (ACh) nicotinic receptor (nAChRs) subunit expression. Notably, changes in nAChR gene CHRNβ2 expression within the dorsal striatum (DS) are associated with increases in anxiety-like behavior, motor dysfunction, and impaired learning all of which are characteristic of Fetal Alcohol Spectrum Disorders (FASD). FASD is caused by prenatal alcohol exposure (PAE), which is prevalent among young adults of reproductive ages;

however, it is yet unknown how PAE alters nAChR subunit β2 expression and related FASD behaviors. Methods: Pregnant C57B1/6J mice were randomly assigned to either alcohol exposure or alcohol-free controls. Exposure occurred daily from gestational days 12-15. Mice were placed in vapor chambers for 30 minutes of inhalation of 95% ethanol or room air. Approximately a year after birth, tissue samples from the DS were collected for RNA isolation and sequencing. After quality verification using Galaxy software, the relative transcript abundance of DS-abundant transcripts, CHRNA4, CHRNA7, and CHRNB2, were assessed between exposure groups and sexes and compared to previously-assessed behaviors: operant self-administration tasks, open-field activity, and rotarod test. Results: No main effects of sex or exposure on CHRNA4 or CHRNA7 levels in the DS were noted. However, alcohol exposure decreased CHRNβ2 expression in males. In within-group comparisons of gene expression and behaviors, motor coordination was negatively correlated with CHRNβ2 and CHRNA4 levels in offspring that were not alcohol-exposed. However, in PAE offspring, motor coordination corresponded with higher CHRNA7 levels, indicating that PAE may change the relationship between nAChR subunit expression and behaviors.

POMT Mediated O-Mannosylation of Drosophila RPTPs

Travis Richard

Faculty Advisor(s): Dr. Vladislav Panin

Protein O-Mannosyltransferase (POMT) is a family of glycosylating proteins which attach mannosyl sugars at select serine and threonine residues to promote processes such as cellular adhesion and migration. Defects in either POMT1 or POMT2 result in extremely deleterious pathological presentations, most notably resulting in severe muscular dystrophies and extensive brain abnormalities which have been linked to POMT modification of the important cell adhesion protein dystroglycan (DG). However, it has been revealed that in Drosophila, POMT dysfunction presentations are extremely complex, and cannot be recreated through mutation of DG alone. Recent research has revealed that POMT proteins also interact with many proteins which play a role in protein tyrosine phosphorylation is a fundamental process whereby tyrosine residues on various proteins are covalently bonded to phosphate groups in order to coordinate complex processes in multicellular eukaryotic organisms, most notably some critical receptor protein tyrosine phosphatases (RPTPs) which are responsible for transducing signal cascades across cellular membranes by dephosphorylating tyrosine residues, and have implications in crucial processes such as cell adhesion and axonal wiring. In this work, we characterize mutations of Drosophila's LAR-type RPTP, POMTs, and double mutants of these proteins to reveal that LAR does play a critical role in the characteristic axonal wiring phenotypes of Drosophila POMT mutants by showing that mutation of LAR and one or both POMTs results in aggravation of this presentation, and that these dysfunctions in axonal wiring can be partially recapitulated through mutation of LAR alone.

Adaptive Quantum Network Coding Protocols: Real-Time Simulation and Optimization Using IBM Qiskit

Arjun R Som

Faculty Advisor(s): Dr. Andreas Klappenecker

Quantum network coding provides robust quantum communication networks where information flow over quantum channels is optimally guided. Qubit decoherence, gate errors, and the no-cloning theorem are challenges in previous research that this work puts into practice to improve error resilience and scalability through adaptive quantum network coding protocols on IBM Qiskit, with the addition of adaptive error correction and entanglement-assisted strategies. We use simulation-based modeling to design quantum circuits with embedded error detection and correction mechanisms that adaptively change with network fluctuations. Coding efficiency is assessed for decoherence and gate errors, including schemes for entanglement purification and quantum memory buffers that aim to minimize transmission errors. We measure network fidelity, error rates, and adaptive coding success to assess the viability of such protocols across topologies. Initial simulations show adaptive encoding suppresses decoherence effects, giving higher transmission fidelity and dependability in noisy networks. It allows higher rates of qubit transmission under dynamical conditions than any conventional method. These results illustrate the possibility of real-time adaptive strategies and mark the path toward large-scale, fault-tolerant quantum networks and a resilient quantum Internet.

Room: MSC 2300 E

The Rhetoric of Nuclear Verdicts

DIllen Cooper

Faculty Advisor(s): Dr. Jason Crider

The rise of “nuclear verdicts”—court cases where juries award damages exceeding $10 million—has sparked significant concern in legal, business, and academic communities. While discussions often center on their financial and legal implications, the rhetorical dimensions of these cases remain underexplored. This thesis addresses that gap by examining the persuasive strategies used in public-facing legal advertisements, courtroom practices, and media narratives to influence juror perceptions and escalate award sizes. The courtroom, historically a rhetorical arena, continues to reflect classical traditions rooted in ethos, pathos, and logos, as articulated by figures like Cicero. This thesis situates nuclear verdicts within this rhetorical continuum, highlighting how contemporary practices have adapted classical techniques, such as storytelling and emotional appeals, to modern contexts. The performative nature of courtroom rhetoric—enhanced by multimedia presentations, expert testimonies, and psychological appeals—further amplifies the stakes in nuclear verdict cases. Additionally, the rhetorical framing of these awards as “nuclear” evokes fear and urgency, shaping their broader societal perception. By analyzing historical trends, from “blockbuster” verdicts of the 1980s and 1990s to the present, and investigating the role of techniques like “reptile theory” and “anchoring

tactics," this thesis explores how rhetoric shapes legal outcomes and reflects societal values. Understanding these dynamics is crucial for policymakers, legal professionals, and scholars seeking to navigate and reform this evolving landscape. Ultimately, this thesis highlights the enduring power of rhetoric in shaping judicial outcomes and societal perceptions of justice.

The Left-Handed Code: Reprogramming Nucleic Acid Recognition through Enantiomeric Design

Maria Perez Perez De Alejo

Faculty Advisor(s): Dr. Jonathan Sczepanski

The emerging field of synthetic chemistry has recently introduced L-DNA, the enantiomeric counterpart of natural D-DNA, which demonstrates remarkable properties, particularly its exceptional resistance to enzymatic degradation. While this characteristic positions it as a promising candidate for advanced drug delivery systems, the fundamental understanding of its three-dimensional architecture remains largely understudied. The present thesis aims to address this knowledge gap by exploring its unique structural basis using advanced imaging techniques and comparative structural analysis to resolve the spatial configuration of an L/D-DNA oligonucleotide sequence and provide mechanistic insights into its enzymatic stability. Preliminary findings reveal a mirror-image topology that creates steric incompatibility with nucleases, while molecular dynamics simulations suggest reduced solvent accessibility in critical recognition regions compared to D-DNA. The structural data obtained further explains how L-DNA's inverted chirality disrupts protein-DNA binding motifs essential for enzymatic cleavage. This work establishes the first complete structural blueprint of chimeric DNA assemblies, directly linking their molecular architecture to observed biological properties. We hereby conclude that chiral inversion gives rise to molecular features that challenge conventional nucleic acid recognition patterns. These findings will serve as the groundwork for developing stable synthetic DNA constructs with implications for precision therapeutics and engineered biological systems.

Historical Analysis of African American Female Astronauts in the American Space Industry

Alexis Brasher

Faculty Advisor(s): Dr. Albert S. Broussard

The American astronaut has been an idolized symbol of the United States and its technological and human progress since the 1960s. A select few have been deemed as worthy by the United States to venture into space, not only as representatives of the country, but for humanity beyond this planet's atmosphere. For much of the National Aeronautics and Space Administration's (NASA) history these individuals have mostly been of the same physical creed, the white male. In the 1970s the effort for minorities and women to be astronauts at NASA steadily increased, with the first African American woman, Dr. Mae Jemison, achieving spaceflight in 1992. This paper seeks to analyze the roles and efforts of the six African American women who have achieved space flight. Other than Dr. Jemison, the topic of

female African American astronauts is a field of historic study that is lacking in overall academic research. This paper seeks to be an informative analysis of the six women's achievements in modern history, which will, in context, convey that the topic needs more research in academia. The thesis will contain two main components and a conclusion, that of a brief historical context of African American women's efforts in the American space industry from the 1960s to the 1990s. This context is important to present as it aids in an understanding of the small percentage of African American female astronauts, and the lack there of until 1992. The second section will cover brief biographical information on each of the six astronauts, their accomplishments, and any information on the topic of prejudice based on race or sex that can be found. The paper will conclude with an overall analysis and hopes for future research in the topic of African American women in the American space industry.

High Temperature NMR of Shape Memory Alloys

Andrew Pai

Faculty Advisor(s): Dr. Joseph H. Ross

Shape memory alloys (SMA) are materials with the ability to recover their initial structure after a deformation, making it more energy efficient and resistant to different types of damage. Previous work has shown that Nuclear magnetic resonance (NMR) can be a useful technique in detecting shape memory properties in certain materials by measuring the NMR shifts and NMR relaxation times, inspired by this, this project aims to use similar methods to investigate the properties of shape memory alloys. Evidence suggests that shape memory alloys may exhibit strange behaviors when heated above a certain temperature, so this project aims to investigate NMR measurements of SMAs at previously unexplored temperature ranges. NMR measurements were performed on a sample of nickel titanium zirconium SMA at temperature ranges of 300K - 420K. In particular, measurements of NMR shifts and NMR relaxation times were used to analyze the electro-magnetic phenomenon present in the sample materials such as any martensite transformation or additional glass like transitions. We will discuss our observations of the effect of high temperature heating on shape memory alloys, as well as other phenomenon present. We believe this research will allow for future experimentalists to have a greater insight into the dynamics of SMAs, along with the possibility for improved formulations and developments of further applications.

Oral Session 3: 12:15-1:30 PM

Room: MSC 2300 B

Legal Culture of Civil War: Framing of Section One of the Fourteenth Amendment

Sungeun (Stella) Chung

Faculty Advisor(s): Dr. Ira Dworkin

The first section of the Fourteenth Amendment to the United States Constitution contains four clauses: Citizenship, Privileges and Immunities, Due Process, and Equal protection. Regardless of its significance, section one of the Fourteenth Amendment is considered one of the most controversial pieces due to the use of vague language. For instance, in the Privileges and Immunities clause, the framers did not clearly define what qualifies as privileges or immunities of citizens. Consequently, the vague language of this legislation led to the rise of many conflicting definitions of citizens and their rights. Therefore, through this research, I will be assessing the possible influences in writing these clauses to discover how the framers of the Fourteenth Amendment intended to define this legislation. For the citizenship clause, I will be looking at the cases of Dred Scott v. Sanford and United States v. Rogers to see how they defined citizenship before the Civil War, and how they came to frame the citizenship clause, which included birthright citizenship. For the Privileges and Immunities clause, I will be examining the Fugitive Slave Acts of 1793 and 1850 and the landmark cases, one of them being Prigg v. Pennsylvania. This will allow me to find a possible influence that these legislations and the cases had on a clause that specifically focuses on limiting the state's rights. Moreover, to discuss the potential influences on the writing of the Due Process clause and the Equal Protection clause, I will be studying Titus Basfield, a formerly enslaved person who formed a close companionship with one of the key framers of this amendment, John Bingham, to see if his knowledge of the institution of slavery had any impact in writing these two clauses of the Fourteenth Amendment.

The Lack of Rites and Rituals as a Possible Contributing Factor in the Imposter Syndrome Phenomenon

Chaney McCollum

Faculty Advisor(s): Dr. Barry Boyd, Dr. Jennifer Strong

Previous research has identified that rites and rituals, or deliberate social action occurring in a public context, can embed culture within an organization and its members, leading to the formation or reinforcement of identity. It has also been noted that many people experience a phenomenon labeled imposter syndrome, characterized by feelings of fraudulence pertaining to identity and accomplishments, resulting in increased stress and anxiety. This research aims to pinpoint a connection between rites/rituals and imposter syndrome to illuminate a lesser-studied occurrence and arm organizations with the tools necessary to prevent this issue and address existing occurrences among members. Is Imposter Syndrome related to the lack of tangible rites and rituals to transition intangible

aspects of identity? Most research on imposter syndrome focuses on marginalized communities or undergraduate college students; however, some studies have found that imposter syndrome is not specific. This research will not focus on isolated identities or social structures, allowing for more broadly applicable solutions. It is anticipated that there is a connection between imposter syndrome and the lack of tangible rites to transition or develop intangible aspects of identity. This is a qualitative study on imposter syndrome with three objectives: (1) Determine the existence of a connection between imposter syndrome and rites/rituals. (2) determine the commonality of imposter syndrome, and (3) determine if individuals experiencing imposter syndrome feel bonafide in their social structures. The field of social sciences has discussed imposter syndrome as a phenomenon that impacts many; it is up to us to find a solution.

Reducing the Burden: How U.S. Mothers and Fathers Conceptualize Giving and Receiving Care within the Family

Kaylie F. Sauceda

Faculty Advisor(s): Dr. Allegra J. Midgette

Care is a fundamental human experience that shapes how people build and maintain relationships. Midgette and Ferreira (2024) described care in the family context as ongoing attention, responsiveness, and involvement in meeting the needs of others. The current study explores parents' experiences, examining how U.S. mothers and fathers give and receive care within their families, while also uncovering the unique aspects that distinguish the experiences between the gendered roles. The study included 26 parents (14 mothers and 12 fathers), all U.S. citizens currently living with their child and co-parent. Qualitative data was gathered through in-depth virtual interviews, which was coded and analyzed inductively using reflexive thematic analysis (Braun & Clarke, 2022). Thematic analysis of the most prominent codes related to care experiences identified three main themes: (1) “Caring for me is helping me care less,” recognizing the reduction of caretaking burdens as a form of care; (2) “Caring by being present for the person,” highlighting emotional presence as a central aspect of care; and (3) “Gendered distinctiveness in care experiences,” revealing differences in how mothers and fathers perceive and enact care. These themes illustrate what parents value and recognize when receiving care within their family, as well as the unique ways mothers and fathers approach caregiving. The findings suggest that mindful caregiving toward parents is an important yet often overlooked component of family well-being. Future research should prioritize understanding parents' experiences of receiving care and investigating the factors that contribute to differences between mothers and fathers in these experiences.

Room: MSC 2300 D

Computational Study of Copper-Mediated Lipid Binding to TRAAK

Rachel Sun

Faculty Advisor(s): Dr. Daniel Tabor

TRAAK is a two-pore domain K+ channel comprised of four transmembrane helices (TM1 to TM4), an extracellular helical cap domain, and two pore-forming regions per chain (P1 and P2). Metal ions, such as Cu2+, are recognized for their ability to affect the function and structure of membrane proteins, including TRAAK channel. The Laganowsky group has discovered that Cu2+ selectively enhances the binding between phosphatidylserine (PS) and TRAAK. The functional importance of the binding complex is unclear. The structure of TRAAK with Cu2+ and PS was determined with cryogenic-electron microscopy (cryoEM) by the Laganowsky group. It was found that Cu2+ acts as a bridge for the serine headgroup of PS and two histidine residues (H174 and H178) on TM2. Metal ions forming selective bridges between lipids and membrane proteins was uncovered. This binding site has not been computationally studied. We are studying this binding site computationally by determining the structural basis for how Cu2+ regulates TRAAK-PS interaction. The model of the TRAAK channel was based on the Protein Data Bank entry 4WFF crystal and the cryoEM structure. The channel was inserted into a lipid bilayer with the CHARMM-GUI webserver. The simulations of the system are run in AMBER22 with AMBER ff14SB force field for the protein and Li-Merz 12-6-4 potential for the Cu2+ ion. The alignment to the experimental structures was based on minimizing the root-mean-square deviation (RMSD) between the target and reference coordinates. We calculated the difference in alpha-helix angle and RMSD of the simulation holo and apo forms. Our findings show this important cofactor affects overall protein structure, which could explain how Cu2+ affects this protein functionally.

Surpassing the Invisible Borders

Gaby Flores

Faculty Advisor(s): Mr. Samuel Woodfin, Dr. Elizabeth Robinson

The concept of individuation is a process coined by the psychoanalyst Carl Jung in which an individual throughout their life seeks self-actualization through personal psychological amendments and facilitates their self expression according to their unique values. In the modern day, the engulfing nature of capitalism and consumerism have skewed individuation into a process in which psychological transformation is dependent upon the demands of capitalism. Capital ingrained itself into the psyche of our culture, and this is noted by Mark Fisher, author of Capitalist Realism, when he speaks of the way in which consumerism has entered our dreams and unconscious desires. The fairytale in its narrative mode, promotes individuation through its narrative structure, archetypal patterns, and surrealist elements. It is the fundamental introduction to the human psyche and allows for the awakening of the imagination and for the remedying of overwhelming human struggles. The creative work produced

along with this thesis, The Invisible Border and Other Short Tales, exemplifies the motifs of the fairytale and how they are arranged to convey the framework of individuation separated from capital.

Building a Training Dataset for EDA Applications

Vishnuvardhan Ramesh

Faculty Advisor(s): Dr. Jiang Hu

Electronic Design Automation (EDA) tools have been used extensively in the past few decades to speed up the process of chip design. These software tools typically use heuristic algorithms to solve NP-hard problems, such as the optimal placement of gates and satisfying design constraints when doing routing. With the increase in transistor count over the past few decades, the complexity of algorithms in EDA tools has also grown, leading to longer times to find optimal solutions. Recently, machine learning techniques have been introduced to improve upon current algorithms and create more efficient solutions. This study goes through the process of creating training data for a Convolutional Neural Network (CNN) model that seeks to improve both clock power and circuit timing through flip-flop incremental placement. The study builds on previous research on this topic by using training circuits with a much higher cell count compared to before, training the machine learning model on larger circuits. Using various parameters in the chip design workflow, preliminary analysis shows a diverse spread of performance and power metrics in the logic synthesis and global placement phase. Further research will go through expanding training data through the clock tree synthesis phase, completing the machine learning model, and testing the model with other benchmark circuits.

AI-Assisted Diagnosis: Evaluating ChatGPT's Utility in Preliminary Medical Assessment

Anjali Hole

Faculty Advisor(s): Dr. Tracy A. Hammond

The integration of artificial intelligence in healthcare has shown immense potential in revolutionizing the delivery of medical services, especially in diagnostics and preliminary assessments. As AI-driven tools become increasingly sophisticated, their ability to assist in healthcare applications like diagnosis and telehealth is garnering significant attention. This research focuses on evaluating ChatGPT's capability to assist in preliminary medical diagnoses by analyzing its accuracy, safety, and potential integration into telehealth platforms. The research employed a mixed-methods approach, combining quantitative analysis of AI-generated diagnoses with professional medical assessments and qualitative evaluation of ethical implications, safety concerns, and associated risks. The study aimed to identify the strengths and limitations of ChatGPT in handling medical inquiries and generating preliminary diagnoses while addressing the nuances of ensuring safety and reliability in patient outcomes. Furthermore, it explores the ethical implications of relying on conversational AI in healthcare, such as potential biases, liability concerns, and patient data privacy. By providing evidence-based insights, this research seeks to establish clear guidelines for the safe and effective implementation of AI tools in healthcare settings, with a focus

on enhancing telehealth platforms. This investigation is critical as it addresses the rising demand for accessible and affordable healthcare solutions while ensuring that AI applications meet the rigorous safety and ethical standards required in medical diagnostics.

Oral Session 4: 1:45-3:00 PM

Room: MSC 2300 B

The Way Meat Loves Salt: An Exploration of Emotional Catharsis and Human Limitations Within the Contemporary Horror Story

Caroline McFadin

Faculty Advisor(s): Dr. Lowell White

Within the Horror genre, the deficiencies and resilience of being human are exploited to a near formulaic degree: the protagonist is faced with some unforeseen evil, the protagonist and this evil are faced against each other and it is here that the limitations of the body are tested, and just at the final, critical moment when all hope seems lost, the protagonist develops a “second wind” and defeats their evil. It is this “second wind” that drives the essence of this thesis. That key moment between life and death in which sheer human instincts force us to choose life. Like tearing of muscles while working out that tones and hardens, likewise this thesis explores the tearing of the human spirit, that which tones and hardens. Indeed, if the body is itself weak, then it is the spirit of the person that makes it less so, the soul which provides this resilience which serves as the key unifier in this work. Cathartic acceptance in the face of drastic, even traumatic change manifests within these characters despite even the more horrific of circumstances, thus denoting a sense of moral ambiguity which begs the question: is survival the happier ending? The intended goal of this thesis is to build on this question through a collection of short stories, all of which explore themes of emotional catharsis in response to trauma and the limitations of the body in both mind and matter. This thesis breaks down the metamorphosis of each character as a tangible manifestation of the mental, and in turn, establishes a moral obscurity that readers are encouraged to resolve once these characters begin to welcome this change, for better or for worse. Quintessentially, it has been said, “that which does not kill us makes us stronger.” To which this thesis replies, “prove it.”

The Politics of Anger: Gendered Perceptions of Female Anger in Political Discourse

Chloe Kim

Faculty Advisor(s): Dr. Sara DiCaglio

This thesis talks about the gendered perceptions of anger in political discourse, focusing on how women's emotional expressions, particularly anger, are received in the public media. It begins by

defining anger as both a personal and political emotion, showing how societal and cultural forces influence the ways in which women's feelings are interpreted in political contexts. In particular, the thesis considers how emotions like anger are pathologized when expressed by women, drawing connections to social movements such as #MeToo, which challenges the idea of female behavior in power structures. The study contrasts masculine rage, often deemed acceptable or even necessary in political rhetoric, with the portrayal of women's anger as irrational and dangerous. Key case studies of Hillary Clinton and Kamala Harris showcases how these gendered expectations manifest in real-world political scenarios, such as the media's portrayal of Clinton's emotional expression during the 2016 election and the racialized and gendered scrutiny of Harris during her vice-presidential campaign and tenure. shape political participation, leadership, and the broader discourse on power and representation.

A Critical Exploration of Animal Shelters through Companion Animal Ethics and the Case Study of Human-Dog Relationships

Hailey L. Baker

Faculty Advisor(s): Dr. Emily Brady

Animal ethics is a complex field involving various moral considerations and philosophical approaches that examine how animals are treated and viewed. These approaches include utilitarian, rights, deontological, and contextual/relational, and using these approaches can help us understand the ethical obligations that we owe different animals, specifically companion animals. Companion animal ethics is a specialized field in animal ethics that focuses on the relationship between humans and companion animals and the context of that relationship. This approach can be applied to the human-dog relationship and offers specific responsibilities and perspectives that are determined by their relationship to each other. Understanding the distinct relationship between humans and dogs provides a basis for knowing what is owed, deserved, and needed by both parties. My research focuses on analyzing the human-dog relationship in this contextual manner through case studies and literature review to determine what obligations we as humans owe dogs to negate, decrease, and prevent animal abuse, overwhelming numbers, and unnecessary euthanasia of dogs in animal shelters.

The Dissonance of Daughterhood: Analyzing Father-Daughter Relationships in Evelina

Caitriona R. Devlin

Faculty Advisor(s): Dr. Mary Ann O'Farrell

The patriarchy socializes daughters to be under the control of their fathers while expecting daughters to love their fathers as well. These circumstances were more extreme in British society in the 18th and 19th century since the control fathers had on their daughters extended as far as choosing a husband, thus controlling the daughter’s entire future. Society’s expectations of obedience to and love for the father created a dissonance in the mind of the daughter, who struggled to establish her own identity

while still loving the patriarchal figure that withheld that identity from her. Novels published by female authors during the Georgian period offer insight into this dissonance through their portrayals of father-daughter relationships inspired by the authors' lives and environments. Previous work on father-daughter relationships in novels tends to psychoanalyze the characters, but this presentation utilizes a feminist and historical lens to analyze daughters' expectations and ideals for fatherhood in the face of the expectations imposed on them by the patriarchal society. This presentation will analyze Evelina by Frances Burney, as the novel includes prominent father-daughter relationships that illustrate the societal expectations for both roles at the time. Using this analysis, this presentation seeks to identify the heroines' expectations and ideals for fatherhood and how those beliefs affect their views on their own freedom and independence.

Room: MSC 2300 D

The Catholic Church's Shift in Death Penalty Stance and Its Contemporary Significance

Isabella Gonzalez

Faculty Advisor(s): Dr. Amir Jaima

Historically, the Catholic Church has opposed the death penalty, but did not reject the practice in its entirety. In 2018, Pope Francis formally clarified the church's position of opposing capital punishment in his revision of the Catechism of the Catholic Church, deeming it inadmissible in all cases and stating that it is an attack on the inviolability and dignity of the person. My study aims to investigate the causes of this shift toward opposition and examine how this new perspective can provide a morally significant contribution to the current discussions around the death penalty in the United States. I will focus on the theological and philosophical motivations for the Church's change of stance on capital punishment, which, in brief, relates to the sanctity of human life. A similar premise relating to the sanctity of human life motivates the Church's opposition to abortion, euthanasia, and suicide. I am particularly interested in the Church's previous reasons for considering the death penalty exception to this general tenet, and how their rationalizations are similar to other secular endorsements of capital punishment. The Catholic Church is one of the most powerful moral institutions in the world, and its influence on changes in public opinion has the power to drastically alter millions of people's perspectives. A new paradigm for assessing the morality of the death sentence, the likelihood of redemptions, and the inviolability of human dignity will be made available by this research. Ultimately, through a critical philosophical inquiry, my study aims to shed light on the rationalizations for the Catholic Church's views on capital punishment and whether these reasons might appeal to the broader U.S. legal context.

Typhoon: A Slice-Scrambled In-Place LSD Sort for Large-Scale Datasets

Zelun Liu

Faculty Advisor(s): Dr. Dmitri Loguinov

In this paper, we design a fast in-place LSD radix sort for data-intensive applications. Our framework, which we call Typhoon, drops the histogram pass on each level of the sort except the last one, incorporates a high-performance architecture for dynamically expanding output buckets through immediate reuse of input slices (i.e., low-overhead memory blocks), and includes a number of optimizations that reduce pipeline stalls due to cache conflicts and read-after-write stalls. Because Typhoon scatters slices in each bucket randomly across RAM, it has to employ novel mechanisms for non-linear prefetch that combat tendencies of the CPU to pollute the cache on each jump. At the end of the sort, Typhoon uses OS virtual-memory primitives to unscramble the slices and put them in correct order within the input buffer. Results show that Typhoon achieves a significant single/multi-core improvement over the existing methods, including recent AVX-512 efforts from Google and Intel, often doubling or tripling their performance.

Machine Learning for Estimation of Ultrasound Scatterer Size

Ashlyn M. Melichar

Faculty Advisor(s): Dr. Kenneth Hoyt

Recent work in the ultrasound field involves a technique known as tissue characterization to monitor soft tissue for function and disease. A component of tissue characterization involves studying the size and spatial distribution of acoustic ultrasound scatterers. However, current size estimation techniques are computationally expensive and can constrain ultrasound's real-time imaging capabilities. To address the need for quicker and more accurate scatter size estimation methods, this project employs an integrated approach of utilizing B-mode and H-scan ultrasound images with a convolutional neural network architecture to quantify average scattering size in tissue-mimicking phantoms. In this study, three tissue-mimicking phantoms were created, each embedded with a different-sized monodisperse ultrasound scatterer. The three classifications of scatterers in this study were 15, 30, and 40 Âµm in diameter. Approximately 2500 ultrasound images were collected for each classification by using the radiofrequency data to reconstruct images in MATLAB. Each image was also processed using H-scan techniques to create colorized images corresponding to the approximate frequency content of the scatterer signal. The processed images were then randomly split into training (60%), validation (20%), and test (20%) datasets. These images were utilized to develop a convolutional neural network which was modified based on the MobileNet architecture for the classification of ultrasound images and the estimation of tissue characterization parameters. In classification accuracy, the model was able to obtain approximately 90% accuracy. This far exceeded the baseline for random sampling (33.33%), making a convolutional neural network a promising choice for the rough estimation of scatterer size.

Virtuous and Vicious LLM Usage in K-12 Classrooms: Exploratory Teacher Interviews with a Virtue Ethics Framework

Carlos D. Vazquez

Faculty Advisor(s): Dr. Tracy Hammond, Dr. Glen Miller

The rise and rapid adoption of ChatGPT and similar Large Language Models (LLMs) have left many wondering what the future of education will look like. This issue represents a microcosm of the disruptions that LLMs are poised to bring to many facets of life. In particular, it raises the question of how individuals and institutions can adopt this new technology in a way that will lead to greater flourishing and lead away from harm. This project seeks to contribute to the conversation about AI use in education by considering the effects of LLM usage at a K-12 level from the perspective of Aristotelian Virtue Ethics (VE). It addresses a gap in the current research at the intersection of VE, AI, and K-12 education. VE is chosen as an alternative framework to more common consequentialist model because its emphasis on the formation of individuals is well-suited to the complex and novel ethical questions raised by AI. The research consists of two pieces. In the first, K-12 teachers were interviewed with questions meant to gain insight into how LLM usage is affecting the formation of virtue and vice in students and teachers. The second piece of the research consists of an analysis of the responses and a set of normative recommendations, both from a VE perspective.

Room: MSC 2300 E

Development of a Ring Scintillation Detector with Applications in Detector Calibration and Positron Emission Tomography

Isaac Campos

Faculty Advisor(s): Dr. Rupak Mahapatra

Scintillation detection is a multi-stage process by which a gamma ray, typically emitted by nearby radioactive decay, interacts with a scintillator which converts this gamma ray into many lower energy visible photons, allowing them to be detected by a photomultiplier tube (PMT). The goal of this project is to create a small array of scintillation detectors for the primary use of energy calibration of any other detector through Compton scattering. This setup will consist of a gamma ray source, in my case a radioactive sample, which will fire gamma rays into a subject detector. The gamma ray will then scatter to a nearby scintillation detector. Using the angle of scattering and the energy upon arrival to the scintillation detector, we will be able to estimate the energy deposited in the subject detector from the known initial gamma ray energy and compare with the subject detector reading. This process is called energy calibration and will be used to check the accuracy of the subject detector.

Machine Learning for Computer Architecture IPC Prediction

Aiden Stickney, Osvaldo Castro

Faculty Advisor(s): Dr. Jiang Hu, Dr. Paul Gratz

Accurately predicting Instructions Per Cycle (IPC) is critical for optimizing computer architecture design workflows, as it enables rapid exploration of architectural trade-offs and efficient prototyping. Whereas conventional predictive methods often rely on large, time-intensive machine learning (ML) models, we introduce an early-stage preview technique that uses partial simulation data with smaller, faster tree-based ML models to forecast performance metrics such as cumulative IPC. In this work, we investigate how ML models such as Random Forest, Extra Trees, Decision Tree, and XGBoost can learn from a limited preview of the warm-up phase of simulation to approximate the final cumulative IPC. By training on a diverse set of configurations generated with the ChampSim trace-based simulator, our framework targets x86 out-of-order processors and dynamically captures relationships between microarchitectural parameters and overall performance. In our findings, collecting as few as 10 data points from warmup can preserve a majority of the model's predictive accuracy while eliminating up to 96% of the total simulation time. Using the fully detailed end-of-simulation IPC from ChampSim as a reference, XGBoost achieves a mean absolute percentage error (MAPE) of 2.27% when trained exclusively on post-warm-up data. Including warm-up data in the training set incurs only a modest accuracy penalty (MAPE of 2.69%) while significantly reducing simulation time. Evaluating our trained ML models on unseen architectural components, such as branch predictors or prefetchers, a high level of accuracy was maintained with MAPEs of 2.86% and 4.61%, respectively. The results obtained demonstrate that the proposed technique of utilizing early-stage performance generalizes effectively across unseen architectural variations. Overall, our findings underscore the robustness and practical advantages of this ML-driven approach, offering significant speedups in the field of design space exploration without sacrificing accuracy relative to state-of-the-art methods.

The Effect of Hippocampal Disruptions on Avoidance Learning

Sarabel Weiss

Faculty Advisor(s): Dr. Justin Moscarello, Matthew Alwood

Previous research has established the role of the hippocampus in associative memory formation. Associative memories are essential for avoidance learning, allowing animals to avoid aversive stimuli dynamically throughout their lifespan. Avoidance behaviors are also common among humans with anxious disorders such as obsessive-compulsive disorder and post-traumatic stress disorder. Our understanding of the relationship between the hippocampus and avoidance, and by extension anxiety disorders, is still developing. Our previous work with rats demonstrated that excitation of the dorsal hippocampus (dHPC) leads to enhanced avoidance learning and fewer freezing responses during unsignaled active avoidance (USAA) tasks. Work from another group showed that both excitation and inhibition of the dHPC leads to fewer freezing responses. These findings led us to hypothesize that inhibition of the dHPC would enhance avoidance learning during USAA tasks. This project aimed to explore this idea and supplement past projects by chemogenetically inactivating dHPC neurons directly using a viral vector. The rats were then subjected to USAA tasks and given CNO injections to induce the

production of inhibitory proteins. The administration of CNO coincided with training days during which rats typically make notable progress in their avoidance learning, making differences in behavior more significant. However, behavioral testing revealed no significant differences in performance caused by the hippocampal disruption. These results suggest that inhibition and excitation in dHPC lead to distinct behavioral outcomes.

Oral Session 5: 3:15-4:30 PM

Room: MSC 2300 B

Design of Portable C-Band FMCW Radar System for Thru-Barrier Detection

Alec Ferris, Brandon Black

Faculty Advisor(s): Dr. Kamran Entesari

Frequency Modulated Continuous Wave (FMCW) has become a powerful tool for short-range ranging radars. With capabilities to detect multiple targets that are close together, FMCW radar is suitable for a wide range of scenarios that require the detection of targets that are visually obscured to the user. Effective in short ranges, FMCW radar is also a good candidate for low power systems. This work describes the design of a portable C-band FMCW radar system that is able to detect targets through barriers made of common construction materials. Balancing range resolution performance and commercial availability of parts a center frequency of 5.8 Ghz and bandwidth of 300 Mhz was selected as the most appropriate band to minimize cost and power consumption while still having an acceptable bandwidth to ensure a range resolution of 0.5m. Taking advantage of recent advances in small form factor computing, a data acquisition system was designed using an FPGA based single-board-computer to efficiently process and output the data. The fully portable system is powered by lithium-ion batteries and is integrated into a single chassis. The goal of the project is to demonstrate the effectiveness of the system in detecting targets behind closed doors and walls within buildings.

Variability in Dissolved Organic Matter across Sources within Forested Wetlands of the Southeastern Coastal Plain

Cameron A. Stacey

Faculty Advisor(s): Dr. Yina Liu, Dr. Erik Smith

Forested wetlands play a critical role as headwaters for organic-rich, darkly stained 'blackwater' rivers. The carbon sources in these areas generating the intense blackwater color are poorly resolved. A study conducted from May to late July 2024 examined the optical characteristics (absorbance) and dissolved organic carbon (DOC) content of throughfall, surface water, groundwater, and soil leachate of wetlands on Hobcaw Barony (South Carolina Coastline). To highlight DOC differences between forests, 4 sites

were chosen: two upland forests, one dominated by long-leaf pine (Pinus palustris) and the other by laurel oak (Quercus laurifolia), and two forested wetlands, one dominated by swamp cypress (Taxodium distichum) and the other by swamp tupelo (Nyssa biflora). DOC concentration and variability of throughfall were considerable (2-45 mg/L), but there was no significant DOC concentration difference in throughfall between tree species. Surface and groundwater were enriched with DOC (averaged values 24 mg/L and 74 mg/L, respectively), were variable over time, and significantly different between sites. This suggests seasonality and unresolved mechanisms controlling DOC concentration between forest sites. Specific ultraviolet absorbance at 254 nm (SUVAâ,,â,…â,„), a proxy for aromatic carbon, of surface water (averaged value 10.3) were significantly higher than throughfall (averaged value 4.4), groundwater (averaged value 5.8), and soil leachate (averaged value 4.5), indicating processes alter the source's DOC characteristic once it enters surface water. Results suggest forested wetlands contribute large volumes of colored carbon to the watershed, and further testing should examine degradation mechanisms altering carbon sources properties.

Phylogenetic mapping of sleep loss in wild-caught Mexican cavefish

Owen North

Faculty Advisor(s): Dr. Alex Carl Keene

Sleep is an evolutionarily ancient and nearly universal behavior throughout the animal kingdom. Multiple cave-dwelling populations of the Mexican tetra, Astyanax mexicanus, have converged on sleep loss compared to river-dwelling surface fish. However, the extent to which sleep has been lost across cave populations, and whether sleep loss occurs in wild fish, is poorly understood. We have measured sleep and locomotor activity in 15 distinct populations of A. mexicanus representing multiple lineages that are broadly representative of the 34 cavefish populations identified to date. Strikingly, sleep was largely lost in all cave and hybrid populations that were tested. Hybrid populations retained intermediate eye and pigmentation phenotypes, suggesting sleep loss precedes cave-associated morphological changes. Mapping behavioral changes onto the phylogeny of A. mexicanus populations revealed that independent loss of sleep and elevated locomotor activity has occurred at least three times. Analysis of sleep in the wild confirms that the sleep loss phenotype observed in lab-reared fish is also present in the natural environment. Together, these findings reveal deep evolutionary convergence on sleep loss in cavefish and provide evidence for sleep loss as a primary trait contributing to cave adaptation.

CHIPLLM: Coherent Hardware IP Piracy via Large Language Model

Joey See

Faculty Advisor(s): Dr. Jeyavijayan Rajendran

Due to the complexity of modern electronics, the hardware design process is an expensive and slow undertaking, with a single chip normally costing millions in nonrecurring engineering costs. As a result, the files describing a completed design—the hardware intellectual property (IP)—are valuable commodities. The value of this hardware IP gives rise to hardware piracy, a practice in which bad actors

"steal" a designer's hardware IP and use it without permission. Hardware piracy is a serious problem that costs the industry billions annually and can pose a serious threat to national security. Designers have developed a number of defenses against it. However, many of these defenses were created prior to the existence of powerful large language models (LLMs), leaving open the possibility that they contain critical vulnerabilities to LLM-based hardware piracy attacks. This paper aims to shed light on this issue by evaluating the abilities of a proof-of-concept LLM (CHIPLLM) that we fine-tuned for the purpose of hardware piracy. In particular, we will be examining its performance on hardware description language (HDL) IP, the most valuable form of hardware IP and one as of yet untouched by studies on industrial LLM piracy. Through this evaluation, we can determine whether LLM-pirated IP retains the functionality of the original IP and whether or not it can evade piracy detectors; that is, whether LLM piracy is effective and if it can be detected. The findings of this paper will reveal the severity of LLM piracy attacks and highlight whether designers should be concerned about updating their defenses to address this threat.

Room: MSC 2300 D

Efficacy of Dual-Language Programs in Texas

Ryleigh K. Phillips

Faculty Advisor(s): Dr. Richard Curry

Now more than ever, in our diverse state, country, and world, bilingualism is an indispensable skill to possess. Thanks to Dual-Language learning programs, this skill has become much more accessible to students in Texas. Dual-Language programs allow students to gain fluency in another language early in life and be able to retain this bilingualism later in life, opening the door to endless opportunities. My motivation for this research project is my experience being one of these students myself. In this project I will focus on programs specifically in Texas, where Spanish is the second language. This project is intended to evaluate the efficacy of two main different Dual-Language programs in the state of Texas, Dual-Language 50:50 model and Immersion programs. In my research I combine quantitative data from state reports with qualitative data from interviews with peers which adds a unique element to my research. This combination of data will help compare the intended program benefits with the real-life outcomes of Dual-Language programs. Regarding measuring program success, I separate short term success using standardized test scores, from long term success using language retention and continuing education. Through my research I want to be able to answer the a few main questions of which program is more successful long term, which program is more successful short term, if the program lengths are sufficient to ensure language retention, and of course, do my findings confirm my hypothesis. My hope for this research is that through data analysis and alumni input I contribute to the improvement and overall success of these Dual-Language Programs.

An Aristotelian Analysis of Present-Day City States

Audrey Schabel

Faculty Advisor(s): Dr. David Koepsell

Under the Aristotelian view, the city state is the best form of government and political expression. Currently, few city states exist. This research briefly describes Aristotle's political theory and outlines the requirements for an Aristotelian city state. Then, the research will profile the government, political structure, democratic participation and representation, and self-sufficiency of Singapore and Dubai. Finally, the research will describe and analyze Singapore and Dubai's alignment with Aristotle's conception of the ideal city state. Singapore was chosen for this research because it is a global center for trade and unique in the Southeast Asia region. Dubai was chosen for analysis because, although it is a member of the United Arab Emirates (UAE), it is autonomous enough to be relevant for analysis and will provide an insightful contrast to Singapore, which is fully autonomous.

Evaluating the Social and Behavioral Factors that Increase Risk for Metabolic Syndrome Among Adolescents in East and Central Texas

Mia H. Putnam

Faculty Advisor(s): Dr. Patrick Tarwater, Dr. Jacob Szeszulski

Adolescent metabolic syndrome (MetS) is a cluster of intercorrelated metabolic risk factors that increases risk for future cardiovascular diseases, obesity, and type II diabetes. In our previous work in East Texas, we found that about 9% of students have MetS, which is currently higher than the national estimate of 3-4%. The objective of this study is to evaluate how behavioral and social risk factors predict metabolic syndrome prevalence, and components of Mets, within an at-risk adolescent population in Texas. The study population is from two school-based research projects within elementary and middle schools in the Stroke Belt region of the United States. To improve the current knowledge of risk factors for metabolic syndrome, multivariable logistic regressions will be conducted on this data to analyze how different social and behavioral risk factors predict, mediate, and interact with each other to increase risk of MetS within this at-risk adolescent population. The behavioral risk factors are based on the Theory of Planned Behavior (TPB) and the social risk factors in this study include gender, race/ethnicity, rural or urban status of the school district, and additional socioeconomic factors within each school district. The thesis of this study postulates that behavioral risk factors will significantly predict MetS status among adolescents and social risk factors will mediate and confound the outcome of MetS and its components. The results of this study can be used to further understand the complex risk factors for MetS among adolescents in an at-risk geographic region of the United States and help build stronger primary interventions within school settings for cardiometabolic diseases.

Room: MSC 2300 E

Rise of a New Global Hegemon: How the Open-Door Policy Propelled China to a World Superpower

Allen Zhang

Faculty Advisor(s): Dr. Ren Mu

In the early 2000s, an overwhelming portion of products on American shelfs were labeled with a “Made in China” sticker. Just two decades before, China's market was closed off to the rest of the world, with limited amounts exports flowing to foreign countries. Its sudden transition into the world market in the late 1970s, implemented via the Open-Door Policy, has generated unprecedented levels of economic growth in an extremely short period of time. The influential Open-Door Policy is the focus of this study, as the paper seeks to examine how an unorthodox policy became widely accepted by a predominantly conservative Chinese Communist Party (CCP), how the policy's free-market mechanisms reconciled with traditionally Marxist economic perspectives, and perhaps most importantly, how this policy propelled China from a low income country to one of the most powerful economies in the world. This research first analyzes the shift in social perspectives which paved the way for the Open-Door Policy. In the years leading up to 1978, the prevailing perspective was to embrace economic reforms, and in some ways, embrace elements of free market capitalism. However, this perspective drew heavy backlash, in turn, producing two primary schools of economic thought: one that sought to adapt the Marxist perspective to the changing global economy, and another that sought to protect the sacrosanct traditional Marxist-Leninist values. To fully understand the political climate at the time, this paper will examine how various high-level officials responded, particularly Hua Guo-Feng, the then General Secretary, and Deng Xiaoping, the unofficial yet paramount leader, to the proposals, and how their support became important in the debate for China's future.

Enhancing Physics-Based Simulation on the GPU

Andrew Leach

Faculty Advisor(s): Dr. Shinjiro Sueda

Physical simulation offers otherwise untractable information about realistic scenarios while executing in tens of thousands of magnitudes greater than a single real-world experiment at the same time. That said, modern robotics, reinforcement learning, and interactive real-time experiences share a common processing bottleneck: data availability. The demand for quality, usable results per the same unit of time has grown a thousandfold in recent years, driving many performance optimizations for greater simulation throughput. Advanced collision checking, improved solvers, differentiable gradient-based methods, and many other formations all contribute to greater serial execution of simulations. However, pushing these algorithms to their limits has required sacrificing quality and stability for greater performance, or vice versa. This has been shown in frameworks relying on Gauss-Seidel iterations for improved efficiency, like PhysX or Extended-Position Based Dynamics (XPBD). When given a reasonable

time budget, these frameworks fail to depict certain scenarios, such as the stacking of frictional objects, which are fundamental in our lives. With recent advancements in computing, parallelism hardware such as the graphics processing unit (GPU) has become a necessity for their ability to divide and process large amounts of data in lockstep at low latency, making their effective use a major area of focus for these simulators to investigate. Through this paper, we discuss the strategies, GPU architecture, and optimizations that make the simultaneous execution of over 10,000 unique simulations feasible, all while using new methods to improve upon stability of rigid bodies in various scenarios.

Cicatrize: Vampires as Victims of Intolerant Society

Adriana Movsesian

Faculty Advisor(s): Dr. Lowell White

Vampires were first monsters that animalistically fed on human blood, occasionally concealing their true natures to better hunt their prey. They were both demonic and elusive, draining villages dry and killing pretty young maidens in the night. Modern depictions have shifted, and Vampires are now emotionally complex and richly cultured beings that can even live in human society under the right conditions. However, Vampires still remain the physical, sexual, and emotional predators of humans in these sympathetic portrayals–sometimes more effectively than their earlier counterparts. Though the creatures themselves have changed, the stark power imbalance between the Vampire and its prey remains constant in the fiction surrounding these supernatural hunters of the night. Yet this power dynamic has deeper implications and room for exploration: is predation upon human beings integral to the "Vampire" archetype? Could the Vampire exist without it? Perhaps, most intriguing of all: what would happen if the Vampire lost the ability to predate altogether? Through the lens of systemically disempowered and disenfranchised Vampires, Cicatrize aims to answer such inquiries and explore the nature of a flipped human-Vampire relationship. In a world where the fear of Vampires quickly soured to violence and humans became the main physical aggressors, Vampires were barred from human contact and culture altogether. Thus, they were forced to forge their own unique ways of existing beyond human control and influence, fearing wrath, persecution, and violence. Even more deeply, Cicatrize explores how allegations of monsterhood affect self-image and relationships–and how an outcast can achieve self-actualization in spite of an unaccepting society.

Poster Sessions

Poster Session 1: 9:30-10:30 AM

Room: MSC 2300 C

Poster #1

The Effect of Thrombin Signaling Inhibition After Traumatic Brain Injury on Neurobehavioral Recovery in an Alzheimer's Mouse Model

Saloni Tipnis

Faculty Advisor(s): Dr. Lee Shapiro, Dr. Jaclyn Iannucci

Traumatic brain injury (TBI) affects 2-3 million people a year in the United States, and individuals who have had a mild to moderate TBI have a 2.3-fold increased risk of developing Alzheimer's disease (AD) and other related dementias. Cerebrovascular dysfunction has been well-documented in humans and in animal models of TBI. Identifying shared pathological mediators that contribute to the progression of AD following TBI may allow improved therapeutic targeting. Thrombin is a mediator of cerebrovascular dysfunction, and thrombin has been implicated in TBI and AD pathology. Many of thrombin's detrimental effects have been linked to thrombin activation of protease-activated receptors (PARs) which are expressed on many cell types in the brain and periphery. Therefore, inhibiting thrombin activation of PAR-1 may be a treatment strategy for AD pathogenesis after TBI. We hypothesized that targeting PAR-1 activation will improve the TBI-induced increase in AD pathology. 8-week-old male 5xFAD mice received either lateral fluid percussion injury (FPI) or sham surgery, followed 3 hours later by inhibition of PAR-1 activation via a selective PAR-1 inhibitor (SCH-79797) or vehicle control (DMSO). Behavioral measures included investigation of depression and cognition. Preliminary results from these experiments indicate that FPI caused chronic cerebrovascular alterations in 5xFAD mice. FPI in 5xFAD mice also induced deficits in depression-associated behaviors and hippocampal-associated cognition, and these neurobehavioral impairments were improved by PAR-1 inhibition via that treatment with SCH-79797. Thus, there is chronic cerebrovascular dysfunction in 5xFAD mice that is exacerbated by FPI, and targeting thrombin signaling improves cerebrovascular and neurobehavioral outcomes.

Poster #2

Do Systemic Processes Fuel Pain-Induced Hemorrhage Following Spinal Cord Injury?

Avery Awalt

Faculty Advisor(s): Dr. James W. Grau

Prior work has established that pain (nociceptive) input after spinal cord injury (SCI) increases hemorrhage (bleeding) and secondary injury at the injury site and results in poorer recovery and outcomes for SCI patients. We know this is due to the breakdown of the blood-spinal cord barrier, which allows neurotoxic blood to enter the spinal cord. Other work has shown pain-induced hemorrhage is a brain-dependent process; however, it is unknown whether this effect is mediated through systemic

processes or descending fibers. Additionally, the adrenal glands are a part of the HPA axis implicated in responses to stressful stimuli, such as nociceptive input. The adrenal glands release hormones, such as glucocorticoids, into the systemic circulation. The current study will explore the role of systemic processes in pain-induced hemorrhage through serum transfers and whether the adrenal glands contribute to this potential process. Animals will receive a SCI and, twenty-four hours later, will be injected with serum from animals who previously underwent a SCI, adrenalectomy or sham surgery, and pain or no pain treatment. Locomotor function will be assessed using the BBB scale, and a 1cm section of the spinal cord around the injury will be extracted and assayed for hemoglobin levels. Data from the donors suggest that adrenalectomy decreased locomotor deficit, hemorrhage, and cell death following nociception. Preliminary data from serum recipients suggest that the adverse effects of noxious stimulation is meditated, in part, by blood borne entities.

Poster #3

Analyzing Degradable Polymer Stents in Tissue Phantom using Micro-CT

Mary Rocchio

Faculty Advisor(s): Dr. Annie-Marie Ginn-Hedman, Dr. Staci Horn

Degradable polymer stents are becoming more widely used as they decrease the risk for in-stent restenosis and stent thrombosis. These degradable stents reduce chronic inflammation and allow endothelial regrowth at the implantation site. However, this is a novel approach for stent design, so there is limited research on how best to image degradable stents. These devices are difficult to image because of their similar density to soft tissue, producing low contrast in the images and causing high error when calculating percent stent degradation. This study aims to develop an imaging phantom composed of plastic filament and synthetic tissue that mimics degradable stents implanted in cardiac tissue for micro-CT analysis. PLA, ABS, and ASA filaments were used to model a 3D printed stent in micro-CT scans. The densities were then compared to soft tissue density of pig heart tissue. Synthetic tissues of gelatin, silicone, and polyvinyl alcohol (PVA) were analyzed using x-ray analysis and compared to the pig heart tissue. The filament and synthetic tissue with the most similar density to that of pig will be selected in order to create the smallest difference between the two densities, producing the issue of minimal device-tissue contrast. This will imitate the initial problem of low contrast found while imaging the stents in vitro. The actual and measured volumes of the stent are to be measured to determine how the phantom tissue performed. The results are expected to show the best synthetic tissue to be used to measure how devices degrade over time. With the development of this phantom tissue, medical device designers will be able to more accurately determine how their device degrades post-implantation in in vitro studies with micro-CT imaging.

Poster #4

Sex-Specific Mechanisms of Active Avoidance

Claire J. Pitre

Faculty Advisor(s): Dr. Justin M. Moscarello

Recent advancements in neuroscience research have emphasized sex as an important biological variable (Shansky, 2018). Previous work on the signaled active avoidance (SAA) paradigm, a rodent model of instrumental safety seeking, has focused on the mechanisms of avoidance learning in male subjects. However, previous work in our lab demonstrates that the brain structures supporting SAA in males do not necessarily play the same role in females (Guerra, 2023), suggesting that the neural circuitry of avoidance is sex-specific. My study sheds light on the underlying mechanisms of avoidance behavior in male and female rats. This work is intended to demonstrate how defensive behaviors that are similar or identical in males and females can be mediated by distinct, sex-specific mechanisms. This work may support the ultimate development of effective, sex-specific treatment options for anxiety disorders.

Poster #5

Plugged Into the Grid: Understanding Modern Power Needs Through Electric Vehicle Charging Trends

Alexander Mandanis

Faculty Advisor(s): Dr. Xin Chen

With the current focus on decreasing carbon emissions, there has been a major increase in electric vehicle (EV) use in society over the past decade. Additionally, there has been a move away from fossil fuels for power generation in favor of renewable sources like solar. This change will pose a more significant strain on the electric grid in years to come. Specifically, in the evenings, power demand spikes and solar power production decreases, which puts strain on traditional forms of power generation. This problem becomes more significant each year, as more and more energy is consumed by an increasing population and as increasingly heavy power consumers, like data centers, grow. One way to flatten the overall power generation/consumption curve and to ease the burden on traditional forms of power generation is to shift when EVs get charged. This project analyzes past research and explores publicly available EV charging datasets with algorithms learned in and out of the classroom. Namely, with the use of Python, and the many machine learning libraries available within it, insights about the present and future of power demands are explored within this project. Afterwards, potential solutions are offered, with the context of past successes and failures in the field.

Poster #6

Exploring How Racial Differences in Drug-Related Incarceration Affect Family Dynamics and Community Structures: A Comparative Study of Black and White Men

Addison Silver

Faculty Advisor(s): Dr. Albert Broussard

This study examines the impact of racial disparities in drug-related incarceration on family dynamics and community structures, focusing on Black and White men. By comparing the experiences of incarcerated Black and White men, the research highlights how racial differences in sentencing, arrest rates, and incarceration contribute to profound disruptions in family relationships and community cohesion. The study explores how the incarceration of Black men worsens existing social inequalities, further marginalizing families and communities that are already disadvantaged. Additionally, it investigates how these racial disparities reinforce harmful stereotypes and societal perceptions of Black men as more criminalized than their White counterparts. Through qualitative and quantitative analysis, this research reflects the broader social implications of racialized drug policies and their long-lasting effects on family stability, community resilience, and racial justice. The findings underscore the need for comprehensive reforms in drug-related sentencing and incarceration practices to mitigate the disproportionate impact on Black families and communities.

Poster #7

Developing and Testing a System for Temporal Drug Delivery Through Diet to Inhibit mTOR in the Mouse Model

Varshitha Dhulipala

Faculty Advisor(s): Dr. Jerome Menet

Every cell in mammals follows a 24-hour circadian rhythm of gene expression, regulated by environmental cues, to optimize the timing of physiological processes. In the liver, certain genes are expressed according to the rhythmic patterns of food intake instead of environmental cues. These genes are expressed through mTOR, a nutrient-sensing kinase. In order to study the mechanism of the mTOR pathway in the mammalian model, a temporal system that allows for controlled diet administration is necessary. This project seeks to develop a system that enables the temporal delivery of an mTOR-inhibiting drug via the diet, allowing for the precise tracking of food intake every 3 hours. Previously documented feeding systems were used as a guide and optimized in order to create a novel product that allows for more precise measurement of food intake. New models with 8 rotating feeding compartments, each to be exposed for 3 hours, were 3D-printed utilizing BambuStudio software. Furthermore, preliminary studies have shown that the presence of a certain mTOR inhibitor in the food of the mice results in a significantly decreased food intake compared to when there is no drug present. Therefore, developing a new feeding system also involved testing several taste masking techniques to rescue wild-type food intake levels. The 3D-printed model is to be used to administer food with a taste-masked mTOR inhibitor to mice. The mice are to then be dissected, and liver samples will be collected.

Western blots run on the samples will confirm the inhibition of mTOR in the new feeding system and therefore the functionality of the new model.

Poster #8

Mobile Robot Localization Performance Prediction Based on Map Characterizations

Jaein Cha

Faculty Advisor(s): Dr. Jason O'Kane

Passive global localization techniques like particle filters are essential for autonomous mobile robot navigation. While these techniques are widely applicable, environments with limited sensor information, such as underwater settings, present challenges due to sparse data and repeating patterns. The success of localization methods in such challenging environments heavily depends on environmental characteristics, specifically feature uniqueness within the map. This research addresses a critical challenge: predicting the effectiveness of particle filter-based localization using only occupancy grid maps, without requiring path information or sensor data. The project develops a machine learning approach to estimate localization performance before deployment, enabling optimized mission planning and sensor strategies. The methodology consists of two main phases. First, a simulation environment incorporating random errors in action and observation is developed using ROS2, implementing a low-information particle filter to generate a dataset of localization results. Occupancy grid maps are created, each labeled with the radius of the circle containing 90% of final particles, estimating localization precision. Second, a machine learning regression model will be trained on the dataset to predict the size of the 90% probability range based on map features. This research differentiates itself by focusing on pre-deployment performance prediction rather than real-time assessment. The expected outcome is a predictive model that can evaluate map suitability for passive global localization, particularly valuable in scenarios with sparse and repetitive features.

Poster #9

Test Driven Code Generation

Stella Yang

Faculty Advisor(s): Dr. Philip C. Ritchey

Code generation represents the next evolutionary step in programming, moving beyond traditional paradigms where developers write code compiled into assembly or machine instructions. Instead, we envision a future where specifications are directly translated into higher-level code, allowing developers to express intentions more naturally. This project investigates the potential of code generation within the domain of regular expressions (regex), exploring two regex generation algorithms: AlphaRegex and the L* Algorithm. AlphaRegex is a system that synthesizes regex solutions by iteratively refining candidate patterns using user-provided positive and negative examples. In contrast, the L* Algorithm operates as an interactive learner, constructing a finite automaton representation of the regex through a dialog between the algorithm and a teacher, who provides counterexamples and guidance. This

research contributes to the growing field of program synthesis by proposing alternative ways to capture user intent in software engineering. It highlights how precise and effective tests are not only essential for human developers but also for machines attempting to discern and fulfill user requirements. Future work aims to further integrate user intent into testing methodologies. By minimizing the reliance on manually created positive and negative examples in AlphaRegex and reducing the teacher's burden in the L* Algorithm, we aspire to create more intuitive, user-centered systems for software development.

Poster #10

3D Scaffold for Bone Tissue Engineering

Jose M. Lopez

Faculty Advisor(s): Dr. Akhilesh K. Gaharwar

Craniomaxillofacial (CMF) defects are an extremely common form of injury present in many patients around the world. These injuries can range from simple soft tissue damage to complex bone defects stemming from genetic abnormality, infection, trauma, or oncologic resection. The current clinical landscape often resorts to usage of autografts or allografts to substitute the bone that was lost due to the CMF injury but this method is far from perfect and can lead to complications with patient comfort and further injury from the donor site. To fight these issues the nanoengineered ionic-covalent bioink (NICE) was developed, this bioink showcases a detailed ability to modify printability, mechanical, and degradation characteristics which aid in the design of custom 3D bioprinted scaffolds for use as grafts into CMF defects. This study further explores and highlights the mechanical and chemical properties of NICE bioink scaffolds by examining the effect of differing fill densities within scaffolds on porosity and mechanical strength, determining the osteoconductive nature of scaffolds, and monitoring release and degradation kinetics of scaffolds to determine their ability to load and release therapeutics in junction with their mechanical use. We have shown that differing fill density within a bioprinted scaffold correlates linearly to strength until 70% where strength reaches a plateau indicating a sweet spot for increasing porosity while maintaining a high mechanical strength to allow for greater cell infiltration into scaffolds. Additionally, under accelerated conditions in physiological concentrations of ions these scaffolds develop significant hydroxyapatite crystals which indicate an osteoconductive nature.

Poster #11

Large Language Models for Automatic Hardware Assertion Generation

Evan Pan

Faculty Advisor(s): Dr. Aakash Tyagi

In recent years, large language models (LLMs) have emerged as powerful tools for processing and generating media in a variety of fields. These developments have enabled the automatic creation of media at rates far faster than that of manual processes. In the field of chip design, the majority of time is spent on the verification process. The hardware verification process includes the manual and time-consuming process of writing assertions to avoid bugs and ensure design requirements and constraints

are met. Typically, a verification engineer would manually analyze the specification document and use the information to write the assertions. Here, we explore the application of LLMs to improve this process by automatically generating System Verilog assertions (SVAs) from a specification document and design RTL. We experiment with a variety of techniques to improve the outputs of the LLM. Because generated SVAs are not guaranteed to be syntactically or functionally correct, nor are they necessarily of any quality, we also utilize a multi-component evaluation process to determine the effectiveness of our SVA generation system. In our experiments, we find that while LLMs can struggle to directly output SVAs, techniques such as chain-of-thought and self-refine help improve both the syntactical correctness and quality of generated SVAs.

Poster #12

The Impact of Xylitol on Cognitive Performance in Healthy Adults: A Double Blind, Randomized Control Trial

Avery Dean, Anna Tillinghast

Faculty Advisor(s): Dr. Karen Beathard, Dr. Steven Riechman

In recent years, xylitol has been the focus of extensive research due to its benefits for dental health and potential as a sugar substitute for individuals with diabetes and hypoglycemia. Many mechanisms such as increased regional cerebral blood flow, improved bioavailability of essential vitamins, growth of beneficial bacteria, and reduction of oxidative stress, suggest that xylitol may have a positive influence on cognition. This double-blind, randomized control study aims to determine whether xylitol enhances cognitive function, compared to a glucose placebo. As an initial investigation, this study aims to establish whether such effects exist, rather than identifying the exact mechanisms. Approximately 45 adults aged 18-30 will consume over two weeks a 30g or 8g xylitol or 30g glucose placebo drink after fasting. To test cognitive function, a NeuroTracker speed threshold will be recorded at baseline and intervention days 1, 4, 7, and 14. We expect to find a dose-dependent speed increase in the high and low xylitol group compared to placebo. This finding would make xylitol the only sugar substitute with known positive cognitive effects, whereas other non-nutritive sweeteners have been linked to negative effects. This finding could be impactful for diabetic and hypoglycemic individuals, who are disproportionately impacted by the negative cognitive effects of other sweeteners. In the dental community, the positive cognitive benefits of xylitol could pose as a healthier alternative than fluoride for cavity prevention and enamel remineralization. In short, a positive correlation between xylitol and cognitive performance may have profound impacts on the future of metabolic and oral health.

Poster #13

The Evaluation of Liminal Spaces

Piper Hitchcock

Faculty Advisor(s): Dr. Matthew Vess

Previous research has suggested that individuals high in personal need for structure display a higher disliking for modern art relative to individuals low in personal need for structure. This tendency is thought to be related to terror management theory, which states that meaninglessness is threatening to individuals because applying meaning to life is a crucial element for helping to regulate death anxiety. Therefore, heightened mortality salience drives individuals to negatively evaluate meaningless artwork, particularly those with a high personal need for structure. People high in personal need for structure tend to value simple and unambiguous information. This study examined the prediction that individuals with a heightened personal need for structure will have increased feelings of uncanniness and discomfort toward distorted environments when undergoing a mortality salience induction. We recruited 439 participants from Texas A&M University introductory courses. We measured individuals' scores on the Big Five Inventory and Personal Need for Structure. Participants were then randomly assigned to either a control condition or a mortality salience induction. All participants then 1 evaluated several images (i.e., specifically chosen to illicit feelings of uncannyness) on a series of questions (e.g., how uncanny or eerie they think the image is). Our results revealed that mortality salience did not moderate the effect of PNS on individuals' ratings of the images. Replicating previous research, those high in PNS were more likely to rate the images as more uncanny and less appealing. These findings deepen our understanding of how people regulate meaning and how existential concerns may be connected to perceptions of real and unreal environments.

Poster #14

Mechanical Testing of Extracorporeal Tubing Connections

Colby Wilkens

Faculty Advisor(s): Dr. Staci Horn

Mechanical cardiopulmonary support devices such as Extracorporeal Membrane Oxygenators (ECMOs), Ventricular Assist Devices (VADs), and Cardiopulmonary Bypass (CPB) are external to the body and require blood-contacting extracorporeal tubing to function. Each of the inflow and outflow extracorporeal tubing segments have two attachment points: the cannula that provides vasculature access and the connection between the extracorporeal device and the tubing. For effective functionality of this circuit, these attachments must be secure while not altering fluid flow or compromising hemodynamics. Published literature and research addressing the mechanical integrity and functionality of connector designs, particularly at the specific interface between devices and their tubing, is noticeably scarce. However, there are examples of a few common designs that have been discussed in studies on circuit thrombosis reduction. In this study, four common connector designs were modeled in steel for the purpose of evaluating their mechanical functionality. Silicon extracorporeal tubing was fitted to these connectors before undergoing a rigorous testing regime intended to localize stress to the

region of attachment. Micro-CT and SEM were used to analyze and quantify structural integrity, with focus placed on visible markings of stress on the silicon medical tubing.While this study is still finalizing prototyping and entering early stages of prototyping at the time of writing, it is anticipated that the results between the four chosen designs will be distinct due to their unique properties. Two similar designs are expected to yield comparable results in this study's context, but literature shows that their subtle differences can significantly impact emboli formation.

Poster Session 2: 11:00 AM-12:00 PM

Room: MSC 2300 C

Poster #1

Analysis Over the Implementation of the Strong Teens for Healthy Schools Program

Kaitlyn Nguyen

Faculty Advisor(s): Dr. Jacob Szeszulski, Dr. Andrew McNeely

Research has increasingly shown that the prevalence of cardiovascular disease is closely linked to a lack of essential information for making healthy decisions as well as a limited engagement in physical activity and healthy eating. Starting from youth, dietary and physical activity habits begin to develop and not easily altered into adulthood. Teaching the youth about physical activity and healthy eating as part of their school education can help ensure a healthy life for young people as they progress and grow throughout their lives. Strong Teens for Healthy Schools is an after school program designed for students in underserved communities in grades 6-8 to learn about the importance of physical activity and healthy eating. To advance this research, the Consolidated Framework for Implementation Research (CFIR) is framework that can be employed to help researchers understand how physical activity and healthy eating curricula can be implemented in educational settings. Understanding how Strong Teens aligns with CFIR can help to determine educators' barriers and facilitators to implementing the curriculum into their schools. The Consolidated Framework for Implementation Research allows for the Strong Teens for Healthy School program to understand the problems and potential barriers in the implementation process in the middle schools. The five overarching domains of CFIR will help categorize and specify the types of challenges that arise when trying to implement the Strong Teens for Healthy Schools program curricula into the middle schools. The goal is to alleviate these challenges by developing and implementing effective strategies to overcome the identified barriers.

Poster #2

Effects of Parafascicular Thalamus Activation on Punished Cocaine Seeking in Rats

Monica Dhingra

Faculty Advisor(s): Dr. Rachel J. Smith

Drug addiction can be defined as drug seeking that continues despite negative consequences. Compulsive drug seeking may result from a loss of behavioral flexibility, which is defined as the ability to update existing knowledge when presented with new information. It is well established that substances such as cocaine decrease behavioral flexibility. The parafascicular thalamus (PF) has been implicated in behavioral flexibility, and reduced PF activity may play a role in compulsive drug seeking. We hypothesized that the activation of PF may facilitate punishment learning. To assess the role of PF activation in punishment learning, we used an animal model of addiction. Rats underwent surgery where we injected designer receptors exclusively activated by designer drugs (DREADDs) into PF. We trained rats to self-administer intravenous (IV) cocaine and subsequently activated DREADDs during punishment testing with an injection of deschloroclozapine (DCZ). We measured responding during footshock punishment of cocaine seeking and collected brain tissue once the behavioral tests had been completed. After an analysis of behavioral data and brain tissue, we will be able to investigate how PF activation may affect cocaine seeking. The findings from this research will help us better understand the role of PF in punishment learning and behavioral flexibility.

Poster #3

Quantitative Analysis of Antibiotic Tolerance in Clinical E. Coli Strains

Archisha Biswas

Faculty Advisor(s): Dr. Pushkar Lele

Bacterial tolerance to antibiotics is becoming a growing issue, as bacteria are adapting to persist despite treatment. Previous research has shown that outer membrane proteins called porins are associated with cellular permeability, allowing nutrients and antibiotics into the cell. In this study, an investigation into the mass transport of antibiotics will be characterized via porin channels. 10 clinical E. Coli strains from cancer patients were imaged, half of which display antibiotic tolerant behavior. Ethidium bromide (EtBr), mimicking antibiotics, was visualized in cells using fluorescence microscopy while phenylalanine-arginine Î²-naphthylamide (PAÎ²N) blocked the efflux out of the bacteria. The resulting intensity of the fluorescence in cells were then analyzed. MATLAB code will be used to analyze images and properly characterize the uptake of EtBr in different strains grown with Meropenem, a broad-spectrum antibiotic commonly used for serious gram-negative bacterial infections, often used when other antibiotics are ineffective. Understanding the differences in porin function between strains, in the presence of Meropenem, will provide critical knowledge regarding how 5 out of the 10 clinical strains are tolerating Meropenem. Additionally, several Fluorescence-Activated Cell Sorting (FACS) and Plate Reader experiments were conducted using common antibiotics such as Dexamethasone, Methotrexate Sodium, Promethazine, Ciprofloxacin, and Rifampicin compounds to better understand tolerance towards antibiotics.

Poster #4

Cartilage-Capped Regenerative Osteochondral Plug

Andrew Haney

Faculty Advisor(s): Dr. Melissa Grunlan

Osteochondral defects (OCDs), characterized by localized damage to articular cartilage and subchondral bone, result in pain, swelling, and loss of joint functionality. Current treatments, including grafting techniques and total knee replacements (TKRs), are limited by donor site morbidity, invasive procedures, long recovery times, and diminished post surgery joint performance. To address these challenges, the Grunlan Research Group developed the first-generation cartilage-capped regenerative osteochondral plug (GEN1-CC-ROP), a bioprosthetic acellular implant designed to restore cartilage and regenerate subchondral bone through the material's chemistry alone. While the GEN1-CC-ROP combines a 'cap' multi-network hydrogel with natural cartilage like properties and a 'base' biodegradable osseous scaffold, its fabrication process proved inefficient and unreliable. This study aims to advance osteochondral repair by developing the second-generation cartilage-capped regenerative osteochondral plug (GEN2-CC-ROP) with an improved fabrication method leveraging electrostatic adhesion. The new design incorporates a charged connecting network (CN) that infiltrates the porous scaffold and electrostatically bonds with a positively charged hydrogel 'cap', enhancing integration and structural stability. Mechanical, hydration, and adhesive properties of various CN formulations were systematically evaluated and compared to the GEN1-CC-ROP CN to identify the optimal CN formulation. Results demonstrated that the GEN2-CC-ROP fabrication method significantly improves implant reliability and integration, while the optimized CN enhances mechanical properties and scaffold hydrogel bonding. These findings highlight the potential of GEN2-CC-ROP as a superior alternative for OCD treatment.

Poster #5

The Impact of Intrathecal Norepinephrine on Recovery Following Spinal Cord Injury

Isabel Moreno

Faculty Advisor(s): Dr. James Grau

A spinal cord injury (SCI) can impact the body's ability to effectively transmit signals and regulate body processes such as heart rate and blood pressure. Norepinephrine (NE), a vasoconstrictor, is commonly administered following a SCI to prevent a fatal loss of blood pressure (hypotension). While this step is necessary to prevent patient deaths, several studies have indicated that it may lead to worsened long term recovery. To better understand where NE acts to create this effect, my project compares systemic NE administration via a subcutaneous (s.c) injection to local NE administration via an intrathecal (i.t.) catheter. All animals receive a thoracic contusion, recover for 24 hours, and then receive NE via a s.c. or i.t. injection. Blood pressure and locomotor function are tested every hour for 3 hours post injection. If the i.t. administration is sufficient to mimic the systemic effect of worsened outcome 3 hours post injection, this would suggest a spinally mediated mechanism. In part one, I replicated the systemic effect of NE in animal subjects (rats). Throughout the systemic administration, a spinal reflex (timed withdrawal from a radiant heat source) was used to verify that NE was impacting spinal function.

Surprisingly, the transient thermal nociception from tail flick testing was sufficient to create a comparable deficit to systemic NE administration and was therefore removed from the next s.c. administration and all i.t. administration. Data on the impact of intrathecal NE are currently being collected.

Poster #6

Characterization of Growth Phenotypes of Coxiella burnetii CBU1198 Effector

Alexa Frei

Faculty Advisor(s): Dr. James Samuel, Dr. Erin Van Schaik

Coxiella burnetii is a gram-negative obligate intercellular bacterium that is responsible for Query (Q) fever in humans. C. burnetii is highly infectious and is primarily transmitted through contact with animal biproducts in industrial agriculture. It is also extremely stable in the environment due to its ability to form small cell variant structures which can persist for prolonged periods and are resistant to many disinfectants. Infection occurs after the inhalation of contaminated aerosols into the alveoli where they are phagocytosed by alveolar macrophages. C. burnetii has been termed a “stealth pathogen” for its ability to evade the host immune system and replicate within phagolysosomal compartments, particularly in macrophages, cells that usually kill invading bacteria. The Type IV B secretion system allows for the release of effector proteins from the phagolysosomal compartment into the cytosol of the host, to modulate many cellular processes and create its replicative niche. CBU1198 is a relatively conserved effector and unpublished data suggests it inhibits type 1 interferon (T1INF) by binding to Janus activated kinase 1 (JAK1). C. burnetii cbu1198::Tn mutant was determined to have a growth defect in bone marrow derived macrophages (BMDMs), but demonstrated better replication than WT in BMDMs lacking IFNAR, the receptor for type I interferons further suggesting a role in the manipulation of this pathway. Growth phenotypes of cbu1198::Tn mutant and cbu1198::Comp complemented strains will be characterized in HeLa cell lines to determine if the growth characteristics are similar to primary macrophages. Additionally, the ability to inhibit the T1INF response will be determined in HeLa cells to see if there are differences between innate immune and non-immune cells.

Poster #7

Synthesis and Characterization of a Photodegradable Macromer for Biosensor Degradation

Varshitha Krishnan

Faculty Advisor(s): Dr. Melissa Grunlan

Continuous glucose monitors (CGMs) have improved health outcomes by providing a continuous collection of glycemic data for the user. However, sensor longevity is reduced by the foreign body response (FBR) and biofouling, a buildup of cell debris around the sensor. Coupled with glucose uptake by immune cells, this skews glucose readings, rendering the device ineffective. Additionally, surgical

replacement of subcutaneous CGMs worsens skin irritation and FBR. Therefore, there is a need for an injectable subcutaneous biosensor with on-demand in vivo degradation. Previously, the Grunlan lab has developed a self-cleaning, thermoresponsive double network (DN) membrane experiencing cyclical swelling with changes in local body temperature, resisting cell attachment and reducing FBR. The tightly crosslinked first network was comprised of N-isopropylacrylamide (NIPAAm), 2-Acrylamido-2-methylpropane sulfonic acid (AMPS), and PAMPSn-methacrylate (PAMPSn-MA). The second network was comprised of loosely crosslinked NIPAAm, AMPS and N-vinylpyrrolidone (NVP). These antibiofouling membranes may be used to house optical glucose sensing assays within CGM devices. However, facile on-demand removal of these membranes is crucial to eliminate the need for surgical removal. In this work, we aim to incorporate a photolabile ortho-nitrobenzyl (o-NB) moiety into a PNIPAAm hydrogel for potential use in a photodegradable glucose biosensor. Herein, we describe the synthesis of the o-NB-PNIPAAm macromer. Chemical structures were characterized by nuclear magnetic resonance spectroscopy, attenuated total reflectance-Fourier Transform infrared spectroscopy, and UV-vis spectroscopy. Key polymer properties (e.g., glass transition temperature, molecular weight, and polydispersity) were also characterized.

Poster #8

The Role of Striatal Glutamate on Punishment Resistance in Habitual Cocaine Seeking Rats.

Kiyan Alrobaire

Faculty Advisor(s): Dr. Rachel Smith

Drug addiction is characterized by compulsive drug-seeking despite negative consequences. In an animal model, rats will continue to self-administer cocaine despite footshock punishment, indicating punishment resistance. Preliminary data from the lab indicates that punishment resistance involves the dorsolateral striatum (DLS), a brain region long implicated in habitual behavior. Here, we investigated how glutamate actions at AMPA receptors in the DLS is involved in punishment resistance and habitual drug seeking. We trained 7 male Sprague Dawley rats in self-administration chambers to receive IV cocaine via a seeking-taking chained reinforcement schedule. Once animals reached the final random interval schedule (RI60), they were given footshock punishment (0.4 mA for 0.3 sec, 1/3 of seeking trials) for at least 2 days and were later tested for outcome devaluation to assess whether responding was habitual or goal-directed. Prior to punishment or devaluation testing, rats were given intra-DLS injections of NBQX or vehicle (PBS). Compared to baseline, rats treated with NBQX showed a greater percent decrease in punishment trials than vehicle treated rats. Animals treated with NBQX also showed a shift towards goal-directed seeking behavior whereas animals treated with vehicle showed a shift towards habitual seeking behavior. We found that vehicle-injected rats showed habitual seeking and punishment resistance, paralleling our previous findings that the RI60 schedule influences punishment resistance. In contrast, NBQX-injected rats instead showed goal-directed seeking and punishment sensitivity, indicating that glutamate signaling at AMPA receptors in the DLS is necessary for habits and punishment resistance. These results shed light on the role of DLS glutamatergic signaling in addiction.

Poster #9

Examination of Capability of Large Language Models (LLMS) in Solving Capture the Flag Problems and Identifying Code Vulnerabilities by using Retrieval Augmented Generation (RAG) Techniques

Josh Mueck

Faculty Advisor(s): Dr. Martin Carlisle

This study examines the process of identifying and exploiting code vulnerabilities using large language models (LLMs). Specifically, it investigates how LLMs perform in solving capture-the-flag (CTF) challenges, addressing gaps in software vulnerability exploitation. To achieve this, we utilized the open-source Llama 3.1 model alongside the OpenWebUI RAG framework, leveraging the Texas A&M Cybersecurity Club's CTF problem collection as the retrieval-augmented generation (RAG) database. The database consisted of JavaScript Object Notation (JSON) files, created by converting individual CTF problems using a Python script. OpenWebUI facilitated a straightforward RAG structure, enabling seamless integration with the Llama 3.1 model. Additionally, PicoCTF problems were used as the testing dataset, allowing for consistent evaluation of the model's ability to identify and exploit vulnerabilities. Successful solutions to CTF problems served as the testing metric for model performance. The results indicate that LLMs exhibit potential in identifying and solving code when supported by a well-structured RAG database. However, the study also found that LLMs and simple RAG frameworks struggle to solve more complex challenges and need enhanced guidance or more robust RAG database structures for success. This research contributed to cybersecurity by examining the effectiveness of LLMs in identifying code vulnerabilities. While promising, the findings suggest that improvements, such as combining RAG with fine-tuning, are necessary to tackle more complex problems. Future studies should explore hybrid approaches to build more capable and resilient models.

Poster #10

Graph Coloring In GraphBLAS

Hemanth Mukesh

Faculty Advisor(s): Dr. Timothy Davis

In computer science, many traditional approaches to graph algorithms rely on iterative and sequential techniques applied to adjacency lists. However, with the emergence of GraphBLAS, a linear algebra-based framework for graph algorithms, a new, more parallel approach to solving graph problems can be explored. GraphBLAS provides a powerful alternative through a robust framework that defines a set of matrix and vector operations to perform operations on graphs. Using concepts from linear algebra, GraphBLAS unlocks the potential for increased performance on several algorithms suited for parallel implementations, including graph coloring. Graph coloring is a fundamental problem in graph theory with applications primarily related to scheduling, such as register allocation or resource management. The concept of graph coloring is to color each node or edge of a graph such that no two adjacent nodes share the same color. While a successful coloring can be achieved with coloring each node a different

color, coloring algorithms aim to minimize the number of colors as well as the runtime. This work explores the GraphBLAS implementation of multiple graph coloring algorithms, including the independent set algorithm, the maximal independent set algorithm, and the Jones-Plassman algorithm. Next, we test and compare the performance of these algorithms against each other as well as against the traditional implementation of graph coloring.

Poster #11

No Poster

Poster #12

A Personalized Framework for Identifying Emotional Triggers for Psychological Wellbeing

Brigham Pettit

Faculty Advisor(s): Dr. Tracy A. Hammond

Student mental health is becoming an increasingly concerning topic among educators and institutions. Mental health and wellbeing solutions that are accessible, effective, and minimally invasive are critical for students to learn to cope and thrive in their high-pressure learning environments. I present a novel design for a system that allows users to report their emotional reactions to events in their personal lives and receive personalized feedback about their emotional patterns and triggers. The system uses a novel arrangement of machine learning and data analysis strategies to synthesize the user's self-reported data into meaningful insights, enabling students to better understand and manage their emotions. For example, students struggling with social anxiety or stress during exams can use this system to identify recurring themes and learn how to cope with triggering circumstances when they emerge. This can be especially helpful for students who feel “stuck” in their personal growth to identify the patterns that are holding them back. The system's privacy and accessibility make it an effective tool for many busy students seeking self-improvement without the need for professional services. It also provides a means for students who might be reluctant to seek professional support to identify patterns and resolve issues that might otherwise go unaddressed. This work is an important step in accessible mental health services. It is by no means intended to replace or delay the seeking of professional help, but rather to assist students in familiarizing themselves with their unique internal landscapes, enabling them to create a healthier relationship with their emotions.

Poster #13

Impacts of an Acute and Gradual Temperature Decrease and Increase on Eastern Oysters (Crassostrea virginica)

Cathy Verneuil

Faculty Advisor(s): Dr. Lene H Petterson

Eastern Oysters (Crassostrea virginica) are a growing agriculture industry in Texas and their presence has significant impacts on the health of an ecosystem. Oyster farms are located in areas prone to weather extremes such as Marine Cold Spells (MCSs) and Marine Heat Waves (MHWs). As ectotherms, their metabolic rate is dependent on the temperature of the environment. During MCSs, their metabolic rate will likely reduce, which can negatively impact growth rate. In contrast, during MHWs, their metabolic rate increases, and if the oyster is not able to source enough food from the water column their growth and survival can be affected. The goal of this research was to determine how two weather extremes (MCS and MHW) affect oyster physiology (as determined by metabolic rate) and growth (shell length/width). To assess MCS, the temperature was decreased over 4 hours from 22.7Â°C to 11.8Â°C and metabolic rate was recorded. This was followed by assessing the chronic impacts of a long-lasting MSC and oysters were therefore maintained at 11.8Â°C for ~ 7 days. To assess effects in the summer where MHW are prevalent, oysters were returned to room temperature (~22oC) for 4 days thereafter they were exposed to an acute rise in water temperature (22.7Â°C to 26.4Â°C over 4 hours) and then maintained ~7 days at the elevated temperature. Preliminary results show that the chronic MCS group had stunted growth while the chronic MHW group of oysters grew faster and larger than the cold group. This information is valuable to oyster farmers and conservation management as it will aid in understanding how oysters are impacted by these extreme events and provide data for solutions to mitigate the impacts of extreme weather events on oyster populations which will have economic and ecological benefits.

Poster #14

Modeling Venous Hemodynamics using a Hemadyne Perfusion System

Rushangi Patel

Faculty Advisor(s): Dr. Abhishek Jain

This thesis investigates the impact of pulsatile venous blood flow on endothelial cells using a 3D-printed HemaDyne perfusion system. By analyzing Doppler ultrasound data from healthy, diseased, and spaceflight-induced venous flow, the study extracts hemodynamic parameters to replicate these conditions in vitro. The vascular endothelium, a key regulator of vascular function, is sensitive to hemodynamic forces. Abnormalities in these forces contribute to diseases like atherosclerosis and venous thrombosis, recently observed in astronauts. This research adapts the HemaDyne system, previously used for arterial flow, to model complex venous waveforms. By pneumatically driving flow in microfluidic channels, the system enables precise replication of physiological and pathological venous flow conditions. The study focuses on engineering vessel-chips lined with human umbilical vein

endothelial cells (HUVECs) to investigate their response to varying flow patterns. The system is designed for extended operation to maintain endothelial cell viability while mimicking physiological and pathological waveforms, including those observed in spaceflight. By bridging microfluidic technology with organ-on-chip systems, this research aims to provide insights into endothelial responses to complex flow dynamics. The outcomes have significant implications for understanding venous disease progression, screening therapeutic interventions, and addressing spaceflight-related health risks.

Poster #15

Feminist Critiques of John Stuart Mill's The Subjection of Women.

Josh Ozoa

Faculty Advisor(s): Dr. Cary J. Nederman

This thesis will explore three variants of feminist ideology and their critiques of John Stuart Mill's The Subjection of Women, one of the early classics of the theoretical literature defending gender equality. These three variants include liberal, intersectional, and and Marxist feminist belief systems. Following a brief introduction, this thesis will be divided into four chapters. The first chapter is a summary of Mill's tenets, arguments, and ideas advocating gender equality in The Subjection of Women. The second chapter considers a liberal feminist critique of Mill's argument, comprised of two roughly equal-length sections: a) a summary of main feminist doctrines; and b) an articulation of how liberal feminists might criticize Mill's views. The third chapter discusses an intersectional feminist critique of Mill's argument, comprised of two roughly equal-length sections: a) a summary of main intersectional feminist doctrines; and b) an articulation of how intersectional feminists might criticize Mill's views. Lastly, the fourth and final chapter addresses a Marxist feminist critique of Mill's argument, comprised of two roughly equal-length sections: a) a summary of main Marxist feminist doctrines; and b) an articulation of how Marxist feminists might criticize Mill's views. This fourth and final chapter will be followed by a brief conclusion summarizing the arguments and findings in the thesis. Overall, the aim of the thesis is to demonstrate how, depending upon which school of feminist thought to which one subscribes, Mill's views can be analyzed from multiple, equally illuminating perspectives. Some of these perspectives may be in support of, others, in opposition to, and some, in support for and opposition to only various facets of Mill's beliefs.

Poster #16

Regulation of Cellular Lipid Distribution by Phosphatidylinositol Transfer Protein NC1 (PITPnc1)

Aditi Chadha

Faculty Advisor(s): Dr. Vytas Bankaitis

Phosphatidylinositol (PtdIns) and its phosphorylated derivatives, phosphatidylinositol phosphates (PIPs), are found throughout the membranes of eukaryotes. Several of these derivatives are implicated in

cellular signaling, and disruptions in these pathways can lead to multiple pathologies, including cancer. PtdIns is phosphorylated through the actions of phosphatidylinositol kinases to generate pools of the signaling lipid phosphatidylinositol-4-phosphate (PtdIns4P), which can be further phosphorylated to produce derivatives that serve as independent messengers, such as phosphatidylinositol-4,5-bisphosphate (PtdIns(4,5)P2) and phosphatidylinositol-3,4,5-trisphosphate (PtdIns(3,4,5)P3). Spatial and temporal regulation of PIP production impacts signaling outcomes that could play important roles during development and growth of tumor metastasis. Phosphatidylinositol transfer proteins (PITPs), are thought to act by exposing PtdIns buried in the cell membrane to biologically insufficient kinases. This provides substrate in a more accessible form, thereby potentiating PIP signaling by producing elevated local concentrations of lipids such as PtdIns4P that are in excess of inhibitory thresholds imposed by negative regulators, such as phosphatases. The specific role of the transfer protein PITPnc1 has not been deeply explored, especially in highly metastatic cancers such as melanoma. In this presentation, the impact on cellular PtdIns4P, PtdIns(4,5)P2, and PtdIns(3,4,5)P3 distribution will be explored following complete knockout of the PITPnc1 gene in two different cell lines, B16F0 and B16F10, one with low metastatic potential and one with high metastatic potential.

Poster #17

Quantitative Understanding of pMad at Different Stages of Cell Division in Germline Stem Cells

Matthew Ball

Faculty Advisor(s): Dr. Gregory Reeves, Dr. Razeen Shaikh

Stem cell decision making made up of pathway signaling is not fully understood, which makes the use of stem cell therapy inconsistent. More research in understanding the pathways by which stem cells differentiate can provide better control on determining the outcome. A key part of this understanding is the Bone Morphogenetic Protein (BMP) Pathway, which is a major biological signaling pathway that plays a part in stem cell decision making. In particular, the BMP pathway occurs in the ovaries of fruit flies, where germline stem cells divide into differentiated cells called the cystoblast. Dpp, the main ligand in the fruit fly BMP pathway, is secreted by the cap cells, which are adjacent to the germline stem cell. Secreted Dpp then forms an extracellular diffusion gradient that extends to the end of the germline stem cell. Dpp activates receptors on the surface of the stem cells resulting in the phosphorylation of the protein Mad. pMad is a type of protein that regulates the expression of genes called transcription factor. Phospho-Mad (pMad) binds with protein Medea (Med) and acts as a transcription factor in the nucleus of the cell, downregulating bam, the factor that causes differentiation in germline stem cells. Despite its central role in regulating differentiation, there is no quantitative measure of pMad in relation to stem cell differentiation/self-renewal, especially at different stages of cell division. Having a quantitative understanding of this system would improve the efficiency and reliability in stem cell therapy. The goal of this project is to document how pMad changes at different stages of cell division. This goal will be achieved by performing ovary dissections Â-Â-and immunostaining to preserve the spatial and concentration of proteins of interest.

Poster #18

Sketch&Teach: Using Sketching and Large Language Models to Teach an AI Agent How to Solve Calculus Problems

Adam Teo

Faculty Advisor(s): Dr. Meng Xia

This paper investigates the use of large language models (LLMs) and sketching techniques to support students' learning of calculus via explanation. Learning by explaining can help students identify weaknesses in their understanding and make connections between topics, especially for calculus learning. From an educational perspective, it is challenging to build a tool that supports explanations pedagogically. For example, when and what questions and feedback the AI agent should provide to stimulate the explanation and learning process. From a computer science perspective, it is not easy to design a tool to support multimodality interaction with agents via both sketch and voice. I conducted a formative study to gather system design requirements from university students who have previously taken calculus at the college level and math education experts. Based on their feedback, I built a web application Sketch&Teach based on these requirements to be used on a tablet, such as an iPad. Sketch&Teach aims to incorporate a sketch interface, voice integration, and an LLM agent to create an all-in-one online learning-by-explaining platform for calculus. The whiteboard will also allow users to write down their problem-solving process. The LLM agent simulates an expert in the topic (such as a tutor or professor) and will take context from the user's sketch and conversations. In addition, the LLM agent will ask questions and provide feedback via voice and sketch to support a more real and engaging learning experience. Finally, I conducted user studies to evaluate the effectiveness and usability of Sketch&Teach.

Poster #19

An Assessment of the Feasibility of Implementing Pyrolysis to Treat Qatar's Municipal Solid Plastic Waste

Meera Jarrar

Faculty Advisor(s): Dr. Ghada Salama

Plastic waste can be broken down into small fragments such as microplastics, which are strongly associated with dire environmental and health issues. This includes the accumulation of plastic in marine animals' digestive systems and cancer in the human body. Therefore, reducing plastic waste is a pressing challenge to be addressed. Countries such as Qatar have been focusing their efforts on reducing plastic waste in favor of more sustainable alternatives, which include reducing the very use of plastic materials, reusing what is available, and recycling what is left. Nevertheless, many types of plastic remain untreated and are left to accumulate, with one such example being polypropylene, which can be found in municipal solid waste sources. To amend this discrepancy, this report aims to assess the feasibility of pyrolysis as an alternative method to recycle municipal plastic waste into a more useful product. More specifically, it proposes the pathway to building Qatar's first chemical recycling plant, based on technical

feasibility, economic viability, and environmental impact. The goals of the paper were achieved by conducting a thorough literature review on the size of plastic waste in Qatar as well as technical information related to pyrolysis, which has proved that the project is indeed technically feasible. In addition, an economic and sensitivity analysis was conducted to assess the economic viability of the plant. Our study has concluded that constructing a pyrolysis plant in Qatar is feasible with the proposed flow diagram and with a total capital investment of 115 million USD. The plant would pyrolyze 30% of the municipal plastic waste into useful hydrocarbon products, resulting in an annual profit of 12 million USD, and proving to be environmentally beneficial.

Poster #20

Benchmarking Large Language Model Inference-Time Reasoning Techniques

Blake Olson

Faculty Advisor(s): Dr. Shuiwang Ji

This work explores the planning and reasoning abilities of Large Language Models (LLMs), focusing on their capacity for structured, deliberate reasoning. Recent advancements in inference-time techniques have significantly enhanced the reasoning power of LLMs. Techniques such as Chain-of-Thought and Self-Consistency allow a base language model to apply System 2 thinking, leading to more structured and deliberate reasoning. As a result, LLMs have demonstrated emerging reasoning capabilities. However, there remains a gap in understanding how to apply these models effectively to specific tasks. In this thesis, I construct a comprehensive benchmark that evaluates LLMs across a diverse set of reasoning tasks, incorporating datasets that test logical, mathematical, and commonsense reasoning. I explore the inference-time reasoning techniques Chain-of-Thought, Self-Consistency, and Tree-of-Thought and evaluate their effectiveness in enhancing reasoning ability. My findings indicate that there may not be a universal inference-time technique, and that scaling inference compute is not always the answer. This thesis ultimately aims to provide deeper insights into the nuanced relationship between reasoning tasks, inference-time strategies, and the effective application of LLMs in real-world contexts, offering guidance on how to best leverage these models for complex reasoning tasks. I aim to highlight the importance of task-specific adaptations and the need for further research into optimizing inference strategies for distinct reasoning domains.

Poster #21

Machine Learning Augmented Intrusion Detection Mechanism within Operational Technology through Utilization of Cyber and Physical Data

Rohit Narayan, Kevin Thomas

Faculty Advisor(s): Dr. Andrew Hamilton

Operational technology (OT) encompasses critical control systems that manage and monitor physical processes in essential infrastructure, including power grids, water treatment facilities, and

manufacturing plants. At the heart of these environments are industrial control systems, which provide real-time monitoring and control capabilities that ensure the continuous operation of vital industrial processes. One common industrial control system, and the technology examined in this effort, is the Supervisory Control and Data Acquisition (SCADA) system. Given the importance of these systems for critical infrastructure, there are now significant cybersecurity challenges present. As we will explore in this report, these escalating cyberthreats pose unprecedented vulnerabilities that tradi- tional security measures struggle to address effectively. The U.S. Department of Defense recognizes the critical importance of strengthening cyber defenses across operational technology systems, impacting military operations, base infrastructure, and supply chain management. This research thus proposes a machine learning-augmented intrusion detection mechanism that leverages data-robust algorithms to improve industrial control system security. By integrating advanced machine learning techniques, the proposed approach aims to develop a more modern and adaptive defense strategy against emerging cybersecurity threats in operational technology environments.

Poster #22

Implementation of Embedded Control Electronics for Self-Contained Soft Robot Module

Manas Rajendran Suresh

Faculty Advisor(s): Dr. Isuru Godage

Continuum arm manipulators represent a growing field in soft robotics, utilizing biologically inspired designs for enhanced flexibility and adaptability in complex environments. Unlike traditional rigid-link robotic arms, continuum arms bend uniformly along their length, achieved through flexible structural materials and linear actuation. This paper presents the design and implementation of the control electronics for a modular, self-contained continuum arm with two degrees of freedom. The arm features a TPU soft chassis embedded with three equidistant tendons controlled by DC motors, enabling omnidirectional bending. Real-time position tracking is achieved using two inertial measurement units (IMUs) placed at the top and bottom of the module. To maintain the mechanical advantage of a compact, self-contained system, all essential electronic components—including battery power, a microcontroller, motors, and IMUs—are housed within the cylindrical chassis. We aim to balance the weight distribution of the components throughout the chassis to ensure the matching of the geometric and mechanical center of gravity. This approach optimizes space utilization and maintains the arm's structural balance, facilitating efficient actuation and real-time motion control.

Poster Session 3: 1:00-2:00 PM

Room: MSC 2300 C

Poster #1

Multimodal Survival Analysis For Colorectal Cancer

David Tanase

Faculty Advisor(s): Dr. Xiaoning Qian, Dr. Byung-Jun Yoon

Colorectal cancer (CRC) has become an increasingly prevalent health issue, especially among younger populations. A particularly challenging subtype, young-onset colorectal cancer (yCRC), is often diagnosed at later stages with metastatic characteristics, increasing treatment difficulty and lowering survival rates. Traditional diagnostic approaches typically focus on single-omics biomarkers, but a more comprehensive approach may lead to higher sensitivity and specificity when it comes to survival prediction, allowing hospitals to allocate resources accordingly. This study proposes an innovative methodology by integrating multi-omics data for predictive performance in the survival prediction of CRC patients. The primary objective of this research is to evaluate whether the integration of multi-omics data can significantly improve predictive machine learning models for patient survival. To train the models, a custom asynchronous downloader was developed to access the TCGA-COAD dataset via the Genomic Data Commons (GDC) API. This allowed for the collection and organization of the multi-omics data that TCGA offers in a format that is best suited for multi-omics analysis. The methodology for model development generally follows two stages. In the first stage, early fusion models are set up for each data type either using pre trained transformers (e.g. ResNet) or custom-built models to generate embeddings. These embeddings are then concatenated into a single unified representation of the patient. The combined embedding is then used as input to a final classification model, trained using a Cox proportional hazards loss function. To evaluate the model, concordance index, partial AIC, and a log-likelihood ratio test are monitored.

Poster #2

Histopathology Techniques for Hydrogel-Based Biomaterials

William H. Otte

Faculty Advisor(s): Dr. Staci Jessen Horn, Dr. Fred Clubb

The use of traditional histopathological techniques for tissue sectioning involve steps centered around dehydration of the tissue product. Dehydration of tissue for traditional paraffin histology is beneficial because it allows the wax to infiltrate all spaces of the tissue and prevent collapse. As a result, there are some classifications of medical devices that render paraffin histology useless for maintaining size and shape while sectioning. This project centered around hydrogel implants as a medical device of interest as their high water content infallibly led to shrinkage after tissue samples containing the device

underwent paraffin histology. In order to avoid the shrinkage caused by processing the hydrogels for paraffin histology, a cryotome sectioning method was established. Through embedding in a water-soluble mounting medium and sectioning at temperatures well below zero degrees Celsius, the size and shape of these tissues were preserved. Techniques for optimal sectioning were developed through altering the mounting chuck and amount of embedding medium placed in the mold. Slide fixation durations were altered in order to optimize the staining procedure. The stained slides were then sent through light microscopy alongside analogous device samples that had undergone traditional paraffin histology. As expected, the samples that had been sectioned on the cryotome exhibited much better retention of size and shape with similar staining output to the paraffin histology slides. These optimized sectioning procedures were then converted into written form for use as a standard operating procedure applicable to similar devices.

Poster #3

Utilizing Ultrasound Techniques for Analysis of Tubing Integrity

Elizabeth Thien

Faculty Advisor(s): Dr. Staci Jessen Horn

Extracorporeal tubing is a critical component of medical devices designed to support patients with organ dysfunction by enabling fluid circulation outside the body. The extracorporeal tubing is particularly vital in devices that assist heart and lung function. However, thrombus formation within extracorporeal tubing is a persistent and serious issue, often leading to blockages or embolic complications that are typically detected only once they become critical. Current inspection methods for extracorporeal tubing for thrombi involve physical manipulation and visual inspection using a flashlight, which is highly ineffective and can lead to a misdiagnosis. This current approach to tubing content inspection is hindered by the opacity and density of blood flow inside the tubing. Visual inspections with the flash light can also involve manipulation of the tubing, which can pose a risk to the structural integrity of the tubing; this could potentially jeopardize patient safety. This study explores the use of ultrasound imaging as a non-invasive solution for examining extracorporeal tubing for thrombus formation. Ultrasound imaging offers several advantages, including the ability to provide real-time insights about blood flow conditions and improves the early detection of clots while preserving the tubing integrity. The research uses ultrasound as a proof of concept for an easy and prompt approach to a lowered risk observation of the tubing wall for assessment of any damage to the structure that could cause additional complications for the patient. This method addresses the challenges that are faced in medical examination for these high risk patients as it offers a safer and more effective approach for monitoring and inspecting thrombus formation in extracorporeal tubing.

Poster #4

Hybrid Natural and Artificial Light to Green Hydrogen Conversion

Syed Umer Ahmad

Faculty Advisor(s): Dr. Konstantinos Kakosimos

Green hydrogen has emerged as a crucial solution for global decarbonization, offering a clean energy source for sectors like transportation, industry, and energy storage. Among various production methods, photocatalytic water splitting is one of the most environmentally friendly, as it uses renewable energy to produce hydrogen without emissions. However, its efficiency and scalability are limited by challenges such as sunlight variability and photocatalyst optimization. This research develops a hybrid photocatalytic system that hybridizes natural sunlight with artificial LED illumination. High-power LEDs with LM3466 drivers supplement natural light during periods of darkness, ensuring continuous and uniform illumination for reliable hydrogen production. To enhance system performance, advanced thermal management is achieved using aluminum-based metal core printed circuit boards (MCPCBs), effectively dissipating heat and maintaining stability. Additionally, the system incorporates optimized photocatalytic materials, maximizing hydrogen production efficiency under constantly varying radiance. Developed in collaboration with the Shell Research Center at Qatar Science and Technology Park (QSTP) and Texas A&M University at Qatar, this pilot system bridges the gap between laboratory experiments and real-world applications. It demonstrates a scalable solution for hybrid hydrogen generation, supporting global sustainability and advancing the transition to clean energy, while reducing greenhouse gas emissions

Poster #5

A Machine Learning Exposition to Efficiently Distinguish Passwords and Honeywords

Michael Morrison

Faculty Advisor(s): Dr. Nitesh Saxena

With the rapid expansion of network-based data centers in the 21st century, databases have faced increasing threats of cyber-attacks. Password breaches in particular remain a critical area of concern due to their potential to compromise sensitive user data. To counteract these risks, the concept of "Honeywords" was introduced in 2013 as a novel method for enhancing password storage security. this idea proposed a set of decoy passwords (honeywords) to be stored alongside the real password, together called a collection of "Sweetwords". This technique aims to deceive attackers into using a honeyword on a login attempt and triggering an alarm. In this paper, we explore the vulnerabilities of honeyword systems under the scrutiny of advanced machine learning and deep learning-based attack frameworks. Specifically, we focus on the ability of these models to discern genuine passwords from honeywords within sweetword sets, challenging the robustness of multiple Honeyword Generation Techniques (HGTs). Our approach involves training and testing machine learning models on datasets comprising previously collected real-world passwords in tangent with generated honeywords. A key

element of this research is transfer learning for feature extraction, word2vec models such as FastText and ByT5 to transform raw sweetwords into numerical embeddings. These embeddings are then used as inputs for shallow machine learning and deep learning models, which are optimized to classify sweetwords. By combining the contextual power of pre-trained embeddings with a suite of fundamentally different models, we aim to contribute to the discovery of latent vulnerabilities in existing honeyword systems while building on prior research that has questioned their long-term viability.

Poster #6

Edge Betweenness Centrality in GraphBLAS

Casey Pei

Faculty Advisor(s): Dr. Timothy Davis

The Edge Betweenness Centrality (EBC) is a metric indicating that a vertex can reach others on relatively short paths based on ratios of number of shortest paths, showing the importance of edges within a network. The EBC algorithm, proposed by Brandes in 2001, has wide-ranging applications in network analysis, community detection, and identifying key infrastructure in transportation and communication networks. Brandes' original sequential algorithm computes the EBC in O(nm) time, where n is the number of vertices and m is the number of edges. While this method is widely used, its performance can be a bottleneck when applied to large-scale networks due to its high computational complexity. A more recent approach, developed by Robinson, adapts the EBC computation to leverage linear algebra techniques for improved performance, reducing the time complexity in certain cases. This paper presents an implementation of the Edge Betweenness Centrality algorithm using the SuiteSparse:GraphBLAS API in C, a powerful tool for performing matrix and vector operations on graphs. We demonstrate that while the linear algebra-based GraphBLAS implementation does not yet outperform Brandes' original algorithm for full EBC computation, a tailored partial EBC algorithm that focuses on specific edge subsets achieves significant speedup, particularly in sparse and large-scale graph scenarios.

Poster #7

The Rich Club Coefficient and Network Randomization with Graphblas

Gabriel Gomez

Faculty Advisor(s): Dr. Timothy Davis

This paper will discuss the implementation of a new set of algorithms built for network analysis using SuiteSparse: GraphBLAS, a linear algebra framework designed for easy implementation of sparse graph algorithms. Sparse graphs are networks where the number of edges within the graph is significantly lower than the possible number of edges; these networks are common in the real world and their structures can be exploited for fast computations. This project will leverage the sparse matrix representation of graphs to implement two algorithms, one to calculate the rich club coefficient of a

graph and another that randomizes a given graph to normalize the coefficient. The rich club coefficient measures the connectedness of high-degree nodes within a graph which facilitates the analysis of network hierarchies. This project will allow for the coefficients of a graph to be calculated thousands of times faster when compared to standard Python implementations of the algorithm. Since nodes of higher degrees are more likely to be interconnected, by having more edges in total, the rich club coefficient of a graph should be normalized by comparing it to a random graph with the same degree sequence. For this reason, this project will also focus on efficiently computing a random graph where every node has the same degree. It implements an algorithm that recursively swaps edges in the graph to obtain a new one with the same degree sequence. This provides a reliable and fast way to get new graphs with prescribed degree sequences.

Poster #8

Investigation of Disordered Regions in Amyloid-B Fibril Polymorphs

Nithanial John

Faculty Advisor(s): Dr. Wonmuk Hwang

This study utilizes computational modeling and molecular dynamics simulations to investigate the structural dynamics of the KVLFFA segment from the amyloid-beta peptide (AÎ², residues 16-21), a key amyloidogenic region implicated in Alzheimer's disease. These peptides aggregate to form plaques, a hallmark of Alzheimer's pathology. Experimental challenges in capturing dynamic molecular behaviors highlight the need for computational approaches to explore structural flexibility and stability under varying conditions. Understanding these dynamics can aid in uncovering mechanisms behind fibril formation and stability, which are important for therapeutic development. Four distinct structural configurations were analyzed: a one-column structure without disordered tails, a one -column structure with disordered tails, a two-column structure without disordered tails, and a two-column structure with disordered tails. Simulations were conducted using implicit solvent models, and the resulting trajectories were evaluated using root mean square deviation (RMSD), root mean square fluctuation (RMSF), solvent accessible surface area (SASA), and angular metrics to provide a comprehensive understanding of structural behavior. Results revealed that structures without disordered tails exhibited greater stability, compactness, and reduced solvent exposure. Conversely, the presence of disordered tails led to significant increases in flexibility and variability, particularly in one-column configurations. The addition of a second column mitigated the flexibility induced by disordered regions, highlighting the stabilizing effect of inter-column interactions. Notably, the observed dynamics reflect key structural characteristics that contribute to the polymorphic nature of amyloid fibrils.

Poster #9

Development of Nickel-based Metal–Organic Frameworks for Enhanced Catalytic Performance

Alaa Laswi, Maria Al-Rabbat, Farah Alawyia

Faculty Advisor(s): Dr. Ahmed Abel-Wahab

The development of efficient, sustainable energy storage and conversion technologies is a critical challenge in addressing global energy demands. Metal-organic frameworks (MOFs) have emerged as transformative materials due to their structural tunability, high surface areas, and versatility. This research focuses on Nickel-based MOFs incorporating Zinc (Ni-Zn) and Molybdenum (Ni-Mo) using 2-methylimidazole (MeIM) as a precursor, with varying surfactants such as polyvinylpyrrolidone (PVP), urea, and hexamethylenetetramine (HMTA). These MOFs are synthesized via a low-temperature solvothermal method under environmentally friendly conditions to preserve the integrity of organic linkers and enhance their catalytic and capacitive properties. The combination of these strategies enables the creation of porous MOF-based materials with high surface areas and abundant active sites, optimized for energy applications. Characterization techniques, including X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), and scanning electron microscopy (SEM), are employed to confirm the structural and morphological features of the synthesized MOFs. Electrochemical evaluations, such as cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS), are used to assess performance metrics, including charge-discharge stability, energy density, and overpotential. By exploring the effects of linker and surfactant variation, this research advances the design of high-performance electrode materials for electrocatalysis and energy storage applications. Integrating sustainable practices with innovative material design, this study contributes to the development of clean energy solutions while addressing critical challenges in energy conversion and storage technologies.

Poster #10

Flight Capacity of the Ambrosia Beetles, Xylosandrus germanus and Anisandrus maiche, across Temperatures

Lisa Rollinson

Faculty Advisor(s): Dr. Jeffery Tomberlin, Dr. Monique Rivera

The ambrosia beetles Xylosandrus germanus and Anisandrus maiche are significant pests of apple trees. When ambrosia beetles invade managed systems, they are difficult to control due to their lifecycle occurring within the tree. Currently, the only approach for management is to apply broad-spectrum insecticides during peak flight activity, which can be detected through monitoring traps. This research investigates how temperature mediates ambrosia beetle flight activity to ultimately use temperature as an indicator for optimal insecticidal spraying time. Wild-caught females were tethered to a flight mill, and distance was calculated from the number of revolutions over two hours. X. germanus flight activity was tested at 21, 23, 25, 27, and 29 °C and A. maiche was tested at 23 and 29 °C. Analysis did not show a

significant difference in flight distance, speed, or number of flights among the temperatures or between the species. This suggests it is possible that despite beetle development and emergence being linked to temperature, temperature itself does not necessarily affect flight activity between 21 and 29 °C. Our findings suggest that X. germanus and A. maiche can effectively fly to new hosts between 21 and 29 °C. These findings may guide future research and ambrosia beetle management strategies.

Poster #11

Language as a Tool for Conservation: Evaluating Marine Protected Area Policies Across Nations

Mary Beth Rayburn

Faculty Advisor(s): Dr. Elizabeth H. Silvy

Research supports that Marine Protected Areas (MPAs) can be effective at increasing biodiversity and aiding in marine life recovery due to overfishing or poaching. However, a comparative language analysis performed across international MPA policies to explain their success or failure remains to be explored. Information, language, and patterns in policies can be assessed to project policy efficacy. This research will examine the language of MPA policies within Palau, the United Kingdom, Australia, Namibia, the United States, and the state of Texas, and evaluate them using a scale based on political, analytical, and operational mechanisms established by Bali et al. in 2019. Australia, the UK, Palau, and the United States were selected for investigation due to their high percentage of MPAs. Texas was selected as its state waters extend further offshore than other states in the U.S. Finally, Namibia was chosen due to its lack of MPA policy and radical change in fishing policy since the rewriting of its constitution in 1990. This study will examine critical aspects of policies to determine whether political, analytical, and operational mechanisms are present. Following evaluation, patterns will be assessed utilizing qualitative analysis of individual policy language to project which patterns, methods, and mechanisms may contribute to making policies effective. Effectiveness is unique to each policy as individual policies have different goals set out in the language, thus, it will be evaluated based on metrics set forth by each policy, rather than a general determiner. In turn, the information gained from this research can be applied to create more impactful policies for domestic MPAs. We anticipate stricter policies that integrate proper enforcement will be most effective.

Poster #12

Movement of Spotted Seatrout throughout the Sabine Lake Estuary

Carly Standbridge

Faculty Advisor(s): Dr. David Wells

Spotted seatrout (Cynoscion nebulosus) are a key species in estuarine ecosystems and hold significant value for recreational fisheries along the Gulf Coast. Understanding their movement patterns and

habitat use is essential for sustainable fisheries management and conservation efforts. This study focuses on the movement ecology of spotted seatrout in Sabine Lake, an estuary situated on the Texas-Louisiana border, with the goal of identifying how environmental parameters such as temperature, salinity, and dissolved oxygen influence their spatial behavior. Acoustic telemetry was used to track the movement of tagged individuals, and spatial maps were generated in ArcGIS to visualize these patterns. Abacus plots in RStudio further explored correlations between environmental variables and movement. Preliminary results revealed variation in movement behavior among individuals, with a notable concentration of spotted seatrout observed in Keith Lake, a secondary bay within the Sabine Lake system. This observation raises questions about the role of wildlife refuges and protected areas in influencing habitat selection and residency patterns for spotted seatrout. By investigating these dynamics, this research seeks to provide valuable insights into the behavioral ecology of spotted seatrout and their responses to dynamic estuarine conditions. The findings have implications for enhancing habitat management strategies and promoting the sustainability of this species within estuarine environments. Moreover, this study contributes to broader ecological understanding by examining the intersection of species movement, environmental variation, and habitat protection in coastal ecosystems.

Poster #13

Examining Associations Between Racial Discrimination and Executive Functioning in Black Emerging Adults

Sanaa Stough-Lacking

Faculty Advisor(s): Dr. Noni Gaylord-Harden

Numerous studies have shown that racism-related stress has deleterious effects on both mental health (e.g., depression, anxiety, substance use) and physical health (e.g., high blood pressure; Carter et al., 2019; Comas-DÃ-az et al., 2019). However, little is known about the impact of racial discrimination on cognitive functioning, especially in Black emerging adults. Executive function describes a set of cognitive skills that are required for goal attainment and control of behavior (Ozier et al., 2019). A recent study demonstrated associations between racial discrimination and changes in a major white matter tract in the brain—the white matter integrity of the corpus callosum, which influences executive function (Okeke et al., 2022). However, research is warranted to examine the direct links between racial discrimination and executive functioning. Given that Black Americans are disproportionately exposed to racism-related stress, and emerging adulthood is a crucial developmental period for executive functioning skills, such as planning and decision-making, the impairment of executive function would be detrimental to the overall well-being of Black emerging adults. As such, the purpose of the current study is to utilize self-report surveys and executive functioning tests to examine associations between race-related stress and executive functioning in Black emerging adults, and the buffering effects of racial identity.

Poster #14

A Geospatial Analysis of Groundwater Arsenic Exposure and Adverse Birth Outcomes in Texas

Aiden Kalainoff

Faculty Advisor(s): Dr. Fikriyah Winata, Dr. Elizabeth Breyer

The Safe Drinking Water Act of 1974 establishes a federally regulated Maximum Contaminant Level (MCL) which public water sources are not allowed to exceed. Prolonged exposure to one of these contaminants, inorganic arsenic, has been associated with higher risk of low birthweight and preterm births. In acknowledgement of its risk to public safety, some states have intentionally reduced their MCL to minimize the potential for the aforementioned health detriments to take effect. Although the climatic environment of Texas exhibits ideal conditions for arsenic to contaminate groundwater, the state has not lowered its MCL for arsenic in public water systems. This study investigates the implications of that decision by geospatially analyzing the correlation between areas that experience high rates of arsenic-attributed birth effects and arsenic contamination in groundwater wells in Texas. Beyond the federal reference values, researchers aim to determine to what extent contamination levels begin to generate fetal complications. Sociodemographic indicators, including race, ethnicity, and median household income are included as covariates. Researchers used spatial regression analysis of geocoded datasets to link geographic locations with rates of associated birth effects to ultimately determine if groundwater arsenic is a serious threat to the physical well-being of Texans.

Poster #15

Giving Nature Its Flowers: The Importance of Nature Connectedness to the Experience of Meaning in Life

Morgan G. Peace

Faculty Advisor(s): Dr. Joshua Hicks

For millennia, humans have relied on nature to meet survival and restoration needs. As such, seeking nature connectedness, a sense of oneness with nature, is evolutionarily sound. Beyond this, nature connectedness contributes to positive outcomes, including improved physical and mental health. Additionally, research indirectly suggests that nature connectedness facilitates meaning in life (MIL)—a multifaceted construct composed of coherence, significance, purpose, and experiential appreciation (EA). MIL is linked to benefits such as greater well-being and reduced risk of age-related cognitive decline. The specific facet through which nature connectedness most strongly influences MIL to produce these benefits is unknown. This study seeks to address this gap by exploring the relationship between nature connectedness and MIL through a between-subjects design. This design uses video manipulations (natural vs. built environment) and self-report measures to assess MIL and its facets, nature connectedness, and additional exploratory measures (i.e., positive affect, awe, authenticity, restorativeness, and pro-environmental behavior). Based on preliminary evidence, we expect a main effect of nature connectedness on self-reported MIL, such that those exposed to the natural

environment video self-report greater MIL than those exposed to the built environment video. We also expect a relative indirect effect of EA on the association between nature connectedness and MIL, such that EA explains the positive relationship even when controlling for potential confounding variables (e.g. positive affect). The results may be beneficial for developing nature-based mental health interventions and in supporting environmental protection efforts through evidencing the importance of nature to MIL.

Poster #16

Activation of the 5-HTR7 Signaling Axis Increases Cholangiocyte Angiogenin Expression Triggering Ductular Reaction and Liver Fibrosis

Mary Falekulo

Faculty Advisor(s): Dr. Shannon Glaser

5-HT7 receptors have modulatory function and are an up-and-coming pharmacological target in the inflammatory fibrotic process. One of the most important peripheral responsibilities of 5-HT in the body is its important roles in the inflammatory process. 5-HT is released in response to injury and/or inflammatory signals. Cholangiocytes are epithelial cells that line the bile ducts and are the target of cholestatic liver diseases such as primary sclerosing cholangitis (PSC). PSC is characterized by fibrosis, reduced bile flow, and ductular reaction (DR-an active phenotype of cholangiocytes). Cholangiocytes participate in a diverse array of cellular processes including the detoxification of xenobiotics and modification of bile. We tested the hypothesis that the 5-HTR7 signaling axis stimulates a reactive cholangiocyte phenotype by inducing angiogenin mediated stress response mechanisms, which promotes inflammation and fibrosis during cholestasis. A Mdr2 KO mice with PSC and mice lacking the 5-HTR7 were crossed. Liver sections were stained with CK-19 (cholangiocyte marker), Sirius red and F4/80 to observe the relative amount of fibrosis, inflammation, and DR. In mice lacking 5-HTR7 treated with a 5-HTR7 antagonist, a lower amount of DR, fibrosis, and inflammation was observed. ANG levels were elevated in cholangiocytes isolated from Mdr2 KO mice and reduced in mice lacking 5-HTR7. Treatment of cholangiocytes with AS19 (5-HTR7 agonist) triggers the gene expression of ANG. A ROS assay was conducted in cholangiocytes treated with angiogen and AS19. The amount of ROS found in these cells increased significantly. These results indicate a connection between the 5-HTR7/ANG/ROS signaling axis in the elevated levels of DR, fibrosis and inflammation during cholestasis.

Poster #17

Virus-host Interactions in Warm Monomictic Lakes across Southcentral USA: Deciphering the Potential Ecological Implications of Viral Infections

Natalie Meklenburg

Faculty Advisor(s): Dr. Jessica M. Labonte

Viruses, specifically phages, are the most abundant and diverse biological entities on Earth. Viral infections play a valuable role in nutrient cycles via host lysis that recycles nutrients or the encoding of

auxiliary metabolic genes. Virus–host relationships also serve a critical role in evolution as vectors of horizontal gene transfer. To explore the relationships between viruses, their hosts, and their environment, we searched for viral sequences in metagenomic datasets of the host fraction (>0.22 μm) from 20 lakes located in the southcentral USA. The locations of these lakes spanned a strong precipitation gradient and had variable watershed land-use practices. The lakes were sampled during the months of April and August in 2021 and 2022. All the lakes are classified as eutrophic and are prone to harmful algal blooms. We calculated the ratio between lytic and lysogenic infections, which can impact nutrient recycling and microbial adaptation, respectively. These ratios were compared to the measured environmental factors to understand the factors that drive viral infections, as well as further our understanding of the role of viruses in these freshwater ecosystems. We also identified the auxiliary metabolic genes encoded by these viruses to evaluate their potential contribution to the carbon, nitrogen, and phosphorus cycles. Finally, we estimated viral abundances and identified potential hosts to describe virus–host dynamics. This project will allow us to better understand the respective roles viruses and hosts have in their environment, and the outcomes of those interactions.

Poster #18

Detection of Orthologous Aminoacyl-TRNA Synthetase Isoforms

Daniel Nguyen

Faculty Advisor(s): Dr. Rodolfo Aramayo

Aminoacyl-tRNA synthetases (aaRS) are essential enzymes with fundamental roles in transcript translation and additional functions in gene regulation, angiogenesis, and inflammation. These roles are often mediated by isoforms generated through alternative splicing, which can result in distinct structural and functional properties. Despite their biological significance, many aaRS isoforms remain poorly characterized, especially regarding evolutionary conservation and functional specialization. Existing computational approaches for isoform analysis have relied on transcriptomic data, which may not fully capture functional insights encoded at the protein level. This study presents a computational framework that integrates proteomic data to confidently identify orthologous aaRS isoforms. Protein domain prediction and multiple sequence alignment (MSA) were applied to characterize shared, unique, and uncharacterized domains. To evaluate evolutionary conservation, an iterative reciprocal blast hit (RBH) method was used. Additionally, CD-HIT clustering was utilized to group sequences and identify representative isoforms for simpler species-specific and cross-species comparisons. This framework suggests the potential to uncover isoform diversity and adaptive evolution by incorporating proteomic data. It highlights both conserved and species-specific features, providing a foundation for future studies of aaRS isoform multifunctionality. The findings enhance understanding of aaRS roles beyond translation and support the development of tools to enable large-scale comparative analyses of isoforms across genomic datasets.

Poster #19

A Zooarchaeological Analysis of Lady Bug (8JE795), an Inundated Archaeological Site in the Lower Aucilla River, Florida

Macayla Sauser

Faculty Advisor(s): Dr. Jessi Halligan

Located in the lower Aucilla River in northwest Florida, the Lady Bug site (8JE795) is a late Pleistocene archaeological site which contains more than two meters of stratified faunal bearing sedimentary deposits. A diachronic zooarchaeological analysis will be performed on faunal material from these strata to better understand the environmental changes occurring in northwest Florida from the late Pleistocene to mid Holocene. The faunal material collected in Â¼" screens during excavation will be examined level by level. Comparative specimens will be used to identify the faunal remains to their furthest possible taxonomic identification using morphological and metric characteristics. The minimum number of individuals (MNI) for each species will be determined. If species identification is not possible, then the genus will be recorded. Observing the changes in percent of terrestrial, aquatic, and semi-aquatic animal species throughout each stratum will help indicate environmental change. Once data collection is complete, a comparative analysis of faunal material from each identified stratum will be conducted, observing changes in species through time. Observing environmental changes in the Lady Bug site throughout the late Pleistocene and mid-Holocene will build on past archaeological research on the Aucilla River, contributing to the knowledge of site use and human occupation in northwest Florida. While faunal remains from many other archaeological sites along the Aucilla River have been thoroughly researched, a zooarchaeological analysis has yet to be done on the archaeological material from Lady Bug.

Poster #20

Realizing the Full Potential of Respiratory Health Evaluation by Leveraging Machine Learning Models

Jack Gauderman, Aditya Biradar

Faculty Advisor(s): Dr. Joshua Peeples

In the field of machine learning, a significant challenge lies in acquiring sufficiently large, labeled datasets to train models. Our research addresses this limitation by developing a robust machine learning pipeline that analyzes light microscopy images for respiratory health diagnostics with minimal training requirements. We leverage Micro-Segment Anything Model (SAM), a vision-transformer-based segmentation framework derived from Meta's general purpose SAM and fine-tuned for microscopy applications. When integrated into our proposed computer vision preprocessing system, Micro-SAM enables accurate and reliable characterization of microscopy images for respiratory health diagnostics. Additionally, we have developed methods for cell characterization of light microscopy images by extracting a suite of features to describe cell texture, morphology, and biological attributes. When validated using both object-level and pixel-level ground truth annotations, the pipeline achieves high cell

detection accuracy as well as precise cell outline quality. This capability streamlines the screening of light microscopy images and reduces the need for labor-intensive laboratory procedures. This is particularly advantageous in high-stress environments, such as those faced by Air Force pilots, where timely detection of cellular changes is critical for safety. This work demonstrates that, even with limited data, machine learning can deliver reliable diagnostics and enhance efficiency across diverse operational scenarios.

Poster #21

Comparison of Respiration Rate Estimation Methods in the Presence of Noise Using a Multimodal Wireless Upper Armband

Rachel Kurian

Faculty Advisor(s): Dr. Gerard Cote

Respiration rate is a critical vital sign used to diagnose cardiopulmonary conditions. With the growing adoption of wearable technologies, these devices are increasingly employed to measure vital signs like respiration rate. However, wearables are prone to noise interference and often rely on a single modality, making measurements vulnerable to biases. This study utilizes a novel wearable, wireless, multimodal upper armband to collect physiological signals. The armband features multiwavelength photoplethysmography (PPG), single-sided electrocardiography (ECG), bioimpedance (BioZ) for cardiopulmonary monitoring, and an inertial measurement unit (IMU) for motion awareness. Data collection was conducted under institutional review board (IRB) approval with 16 participants exposed to various noise sources, such as skin tone variations and motion, simulating real-world conditions for continuous health monitoring. Three respiration rate estimation methods—baseline wander (BW), amplitude modulation (AM), and frequency modulation (FM)—were applied to physiological signals from each modality. Comparing these methods aims to identify the most accurate approach for respiration rate calculation. Additionally, this study seeks to determine which modality is least susceptible to noise, optimizing respiration rate accuracy across different environments. The findings are expected to demonstrate the robustness of multimodal approaches in mitigating noise impacts, thereby enhancing the accuracy and reliability of wearable health monitors for continuous respiratory assessment.

Poster #22

Using the Late Positive Potential to Predict Response to a Brief Positive Affect Intervention

Julia Sandoval

Faculty Advisor(s): Dr. Annmarie MacNamara

Since ~30% of individuals with depression do not respond to current treatments that reduce negative affect, the development of alternative treatments that upregulate positive affect is warranted. Namely,

identifying interventions that reduce worry—a behavioral feature of depression—and the neural markers that predict treatment response may help improve outcomes. Thus, we utilized the electroencephalographic (EEG) event-related potential (ERP), the late positive potential (LPP)—a neural measure of emotional reactivity —to predict which individuals would respond to a brief positive affect intervention, Short-Term Methods for Increasing Life's Enjoyment (SMILE), with reductions in worry. Fifty-one participants, (18-32 years old), with elevated depression symptoms, were randomized to SMILE or Study Tips/ST, a clinician-delivered control condition. Both groups completed the Penn State Worry Questionnaire (PSWQ) at baseline and viewed negative, positive and neutral pictures during EEG at baseline and two weeks later (Week Two). Between visits, participants attended two SMILE or ST sessions. Baseline PSWQ, baseline LPPs in response to negative (vs neutral) pictures, Group (SMILE vs ST), and the interaction between Group and baseline LPPs (negative vs neutral), were examined as predictors of Week Two PSWQ. Across groups, smaller baseline LPPs in response to negative (vs neutral) pictures predicted greater reductions in worry over time. Group significantly moderated this association—individuals in the SMILE intervention with small baseline LPPs reported the largest reductions in worry. Individuals who attend less to negative stimuli at baseline (smaller LPPs) might be better at engaging with positive affect enhancing strategies, making these individuals best suited for SMILE.

Poster Session 4: 2:30-3:30 PM

Room: MSC 2300 C

Poster #1

Designing a Trombone Coil for 3T MR Imaging

Aaliyah Fisher

Faculty Advisor(s): Dr. Mary McDougall

The theoretical design of radio frequency (RF) birdcage coils for MRI scanning often deviates from their anticipated performance based on mathematical calculations. When RF coils are loaded with specimens, achieving the desired resonant frequency frequently requires iterative adjustments of coil parameters, particularly capacitance. These adjustments are time-consuming and often compromise the homogeneity of the coil's magnetic field. Conventional RF coils are typically limited to tuning a single resonant frequency, restricting their versatility in multi-nuclei imaging applications. This limitation creates a need for a clinical probe that is easily adjustable and tunable across a range of resonant frequencies, enabling seamless acquisition of data for various resonating nuclei without the need to exchange probes. This project seeks to address this gap by designing a trombone birdcage coil specifically for small animal studies, such as those involving rats and mice. Unlike traditional designs, this coil will be adjustable through variations in inductance rather than capacitance, facilitating more efficient tuning to multiple frequencies while maintaining field homogeneity. The quality factor (Q factor) and signal-to-noise ratio (SNR) will be systematically measured during benchtop testing and

validated in vivo using small animal models to evaluate performance. This innovative approach aims to improve the versatility and functionality of RF coils, streamlining experimental workflows and enhancing the quality of multi-nuclei imaging.

Poster #2

Tennis Ball Tracking for Serve Speed Estimation

Jason Champagne

Faculty Advisor(s): Dr. Scott Miller

Serve speed analysis is a valuable tool for tennis players, offering insights into performance and technique. However, many conventional methods for estimating serve speed rely on expensive equipment or can be inaccurate, making them less accessible for everyday players. This research introduces a cost-effective alternative designed for the average tennis enthusiast by using a standard smartphone camera to track the tennis ball's motion and estimate serve speed. The methodology employs two distinct approaches–traditional image processing and machine learning–to compare detection accuracy and efficiency. The image processing approach uses frame differencing and DBSCAN clustering to detect and track the tennis ball across video frames, while additional processing identifies court corners to establish a 3D coordinate system. Court corner identification involves edge detection and the Hough Transform to detect lines, followed by intersection analysis to isolate the four outermost corners of the court. Conversely, the machine learning approach utilizes dedicated object detection models to consistently track the tennis ball and court corners. Post-processing refines trajectories by filtering noise and ensuring reliable tracking over time. Finally, parabolic motion equations and 3D transformations are applied to calculate serve speed by combining ball and court corner tracking data. By comparing traditional and machine learning methods, this approach has the potential to make serve speed analysis more accessible to recreational players, enhancing training and performance evaluation without the need for specialized equipment.

Poster #3

Black-Box Offline Optimization via Large Language Models

Ilan Sela

Faculty Advisor(s): Dr. Tie Liu

Black-box optimization considers the scenario in which the objective function is unknown and the goal is to identify the design input that maximizes performance. Solving this problem typically relies on querying the objective function. However, such queries are often expensive in many real-world applications. The challenge of black-box offline optimization lies in having access to only a collection of offline data points, rather than the unknown objective function itself. To address this limitation, traditional approaches often attempt to first learn and then optimize the unknown objective function. Instead of directly learning and optimizing a surrogate function, in this work we propose an alternative approach that leverages large language models (LLMs) to conditionally generate new designs informed

by the offline data. By treating optimization as a generative task, LLMs can utilize their pre-trained and fine-tuned knowledge to easily adapt to the specific context of the offline dataset. Through data experiments, we show that with carefully designed fine-tuning of the LLM, the proposed approach has the ability to generate new designs that significantly outperform the offline dataset. The proposed learning algorithms can be applied to experimental design practiced across many science and engineering disciplines including biology, pharmaceutics, material science, robotics, and manufacturing.

Poster #4

FPGAFuzz: Accelerating Hardware Fuzzing through FPGA Emulation

Molly Jackson, Solomon Rizo

Faculty Advisor(s): Dr. Jeyavijayan Rajendran

Hardware systems are increasingly central to everyday applications, making them an attractive target for threat actors. The growing complexity of these systems, combined with escalating security threats, has created an urgent need for effective hardware vulnerability detection. However, current detection techniques often fall short, struggling to identify all possible vulnerabilities, particularly as hardware designs become more intricate and existing tools remain inadequate. Hardware fuzzing, inspired by software fuzzing, has emerged as a verification technique to uncover hardware flaws by testing iterative inputs on hardware designs. However, this technique faces challenges that stem from simulating hardware, such as inefficiencies in execution speed and limited coverage of specific hardware behaviors. A promising solution is the use of FPGAs–programmable integrated circuits that emulate hardware designs. Although FPGA-based fuzzing offers theoretical advantages in speed, it is similarly hindered by bandwidth constraints when communicating and overheads when collecting meaningful coverage metrics, which reduce its overall effectiveness. In this paper, we present an FPGA-emulation-based hardware fuzzer to detect vulnerabilities. Our fuzzer improves the speed and effectiveness of hardware fuzzing through FPGA assistance while addressing the critical limitations with emulation. We address bandwidth constraints by incorporating optimized instrumentation techniques that utilize the limited bandwidth efficiently, as well as feedback-driven input generation that improves the precision and comprehensiveness of coverage metric collection. The effectiveness of our fuzzer on an open source RISC-V Rocket Core processor.

Poster #5

Unattended Ground Sensors: Power Harvesting for Sensor Operation and Interrogation from Moving Vehicles

Luke Lovelace, Jibin Biju

Faculty Advisor(s): Dr. Aydin Karsilayan, Dr. Jose Silva-Martinez

An unattended ground sensor (UGS) is a device that is used to collect data in an inaccessible or hostile environment. It is mainly used by the military for remote monitoring and detection of enemy forces.

However, there are many possible uses for the technology, such as the one explored in this paper. This paper proposes a low-power UGS system that integrates multiple energy sources, including solar, and thermoelectric energy, to ensure continuous operation. The device has multiple possible sources of power integrated together to run its sensors and store data for future use. The device features an advanced power management circuit capable of optimizing power harvested from these sources. Excess energy is stored in an efficient energy storage system, enabling the sensor to remain operational even when power sources are not actively outputting sufficient energy. The collected data is transferred wirelessly to a moving vehicle, which also provides power for the transmission through a phased array. The phased array is calibrated through a specialized algorithm that works quickly to allow the vehicle that transmits the power to continuously move. The circuits for the power management system, energy storage, and wireless communication subsystems are designed and implemented in CMOS technology using Cadence. Additionally, the calibration algorithm is analyzed using MatLab.

Poster #6

Outcrop Sketch: A Machine Learning Approach for Geological Feature Identification

Carol Geng

Faculty Advisor(s): Dr. Tracy Hammond

The Outcrop Sketch project aims to improve the efficiency and accessibility of identifying key features in sedimentary outcrops. Traditional methods, while effective, are time-consuming and costly, prompting the need for automated approaches. This study leverages deep learning techniques to segment sedimentary outcrop images and identify geological structures. The model was trained using manually labeled datasets, despite challenges such as limited data availability and labeling inconsistencies. Additionally, image segmentation also played a great part for determining rock sections. By integrating several languages and tools, the project demonstrates the potential of machine learning to streamline geological analysis, making it more efficient and scalable.

Poster #7

The Effect of Blue Light on Meat Quality

Amelia Miller

Faculty Advisor(s): Dr. Kerri Gehring, Dr. Jeffrey Savell

The objective of this experiment was to evaluate the effect of blue light on fresh beef meat quality.

Over the course of a 7-day period, steaks (n = 80; 5 experimental days x 8 treatment steaks per day + 8 control steaks per day) were evaluated for objective and subjective color, pH changes, aerobic plate counts (APC), and thiobarbituric acid reactive substances assay (TBARS). The steaks were randomly assigned one of 5 groups (0, 1, 3, 5, or 7 days (D) of exposure to blue light) and allocated as a treatment or control steak. Control steaks were kept in the same cooler under a blackout curtain during the duration of time to avoid exposure to blue light. On D0, all steaks were evaluated for initial objective

color, subjective color, and pH. The assigned 16 D0 steaks were also evaluated for APC and TBARS as well on that day. Each experimental day, the respective 16 steaks (8 treatment + 8 control) were pulled from treatment and analyzed. Subjective color was evaluated with a trained color panel according to AMSA guidelines. Objective color was evaluated with a calibrated colorimeter in triplicate and averaged. pH was measured using a calibrated pH meter in triplicate and averaged. APC was done using 3M petrifilm aerobic count plates (APC) with peptone water and counted following a 48-hour incubation period. TBARS was completed similar to Legako et. al 2018, in duplicate for each steak (n = 16 x 2 = 32 samples per day). The experiment was completed in 2 replications, and the second replication is currently on going. Upon completion, collected data will be analyzed using appropriate statistical methods.

Poster #8

How Inflammation-Driven Lymphangiogenesis Influences Lymph Node Metastasis in Cholangiocarcinoma and Hepatocellular Carcinoma

Sakshi Sanjeev

Faculty Advisor(s): Dr. Sanjukta Chakraborty

Lymph node metastasis is a critical determinant of prognosis in cholangiocarcinoma (CCA) and hepatocellular carcinoma (HCC), two aggressive liver cancers. This study investigates the role of inflammation-driven lymphangiogenesis in facilitating metastatic spread. Using in vitro, in vivo, and computational approaches, it examines the interplay between inflammatory signaling, lymphatic vessel formation, and tumor metastasis. Human CCA and HCC cell lines were exposed to cytokines such as tumor necrosis factor-alpha (TNF-Î±) and interleukin-6 (IL-6) to mimic tumor microenvironment conditions. Lymphatic endothelial cells (LECs) were cultured with conditioned media to evaluate lymphangiogenic activity through tube formation assays. Orthotopic mouse models analyzed lymph node metastasis, while molecular analyses quantified key inflammatory and lymphangiogenic markers. Histological and imaging techniques, including immunohistochemistry and near-infrared fluorescence imaging, visualized and quantified lymphatic vessel density. Therapeutic interventions targeting inflammatory signaling and lymphangiogenesis were tested in vivo, revealing promising strategies to reduce metastatic spread. Computational models and network analysis elucidated the regulatory mechanisms underlying inflammation-driven lymphangiogenesis. The findings highlight the significant role of inflammation in promoting lymphangiogenesis and metastasis, providing insights into potential therapeutic targets. Despite limitations, such as using immunodeficient mouse models, the study offers a robust foundation for future research and translational applications. This work advances understanding of liver cancer biology and holds relevance for veterinary oncology, potentially informing cross-species cancer therapies.

Poster #9

Variability of Star Formation in Low-Mass Galaxies in the Distant Universe

Holden Hatfield

Faculty Advisor(s): Dr. Casey Papovich

The aim of this project is to explore and understand the difference is star-formation rates from rest-frame UV versus the H-alpha luminosity. The H-alpha luminosity comes from the HII regions around newly formed stars. Only the most massive, short-lived, and energetic stars, those being O-type e stars, are capable of emitting enough UV to produce this phenomenon. Upon forming, the hard UV radiation emitted by these stars begin to ionize the surrounding region, which is predominantly composed of neutral Hydrogen (HI). Following this process, the now ionized atomic nuclei recombine with free electrons, which produces a distinct emission; this emission is referred to as H-alpha, or HII. This emission signature is a very strong indicator of star formation, tracing star-formation on timescales of 1 to 10 million yr (Myr), and can be used to determine the star formation rate of a given galaxy. At the same time, the rest-frame UV emission traces the continua of O and B-type stars, and traces star-formation on timescales of 100 Myr. We can then compare the UV and H-alpha emission to determine how bursty star formation is. The initial task is exploring new JWST data covering the rest-UV and H-alpha emission for galaxies in the distance universe at fainter luminosities and lower masses than previously possible. NGDEEP catalogs for galaxies of redshifts z=0.5 through z=2.2, apply dust corrections (to account for the obscuring of UV light), calculate the luminosity in H-alpha and in UV (and convert each to their own SFR = “Star Formation Rate”). I will then measure the relationship between the SFR values from H-alpha and UV luminosity and compare to predictions from theory. Additionally, we can use the ratio of luminosities to determine star formation properties.

Poster #10

Excitation of Dorsomedial Striatum in Rats using Wireless Light Administration

Jaden Carmichael

Faculty Advisor(s): Dr. Rachel Smith

Optogenetics is a method of activating virus-expressing neurons with light stimulation in a temporally specific manner and is traditionally performed with fiber-optic cables. Wireless optogenetics utilizes the same technology to activate or inhibit neural pathways but without the use of fiber-optic cables, allowing for the use of light stimulation in contexts that require the use of a leash or cable (e.g., intravenous cocaine self-administration). We sought to validate the wireless optogenetic technology by exciting D2 receptor-expressing neurons in the dorsomedial striatum (DMS) of Long Evans D2-Cre female rats lever pressing for food, which is hypothesized to reduce responding based on previous studies. Rats were injected in DMS with Cre-dependent AAV driving expression of optogenetic channels (either green-sensitive C1V1 or red-sensitive Chrimson) and then implanted with Neurolux microLED probes (unilateral for C1V1 or bilateral for Chrimson). Rats were trained to self-administer food pellets via a seeking-taking chained schedule of reinforcement, in which completing a random ratio (RR20) schedule on the seeking lever gave access to the taking lever. During test day, rats received light

stimulation every 5th trial out of a total of 30 trials, and response rates on these trials were compared to no-light trials. In the first group of rats, we found that C1V1 did not change response rates, indicating that C1V1 did not effectively modulate neuronal firing. In the second group of rats, we are currently testing Chrimson, which has been shown previously to be more effective in striatum. We expect to find that optogenetic excitation of D2 neurons within the DMS will suppress locomotor behavior, yielding decreased lever pressing for food reward.

Poster #11

Synthesis of Alkyl Chain Derivatives of 4-hydroxy-TEMPO and Analysis of their Electrochemical Properties for use in Organic Redox Flow Battery Systems

Kelsea Bancroft

Faculty Advisor(s): Dr. Emily Pentzer

Solar power and other forms of renewable energy necessitate a way to store and capture excess energy when there is an offset in the supply and demand of these energy sources. One such way to store the surplus energy is through the use of redox flow batteries (RFB), which allow separate control of the power and energy capacity of the systems. Leading systems of RFBs utilize inorganic vanadium and aqueous acidic electrolyte solutions. However, due to their aqueous nature they are challenged by the occurrence of water electrolysis, causing hydrogen and oxygen evolution, which limits the operating voltage and thus energy density of these batteries. An alternative RFB system to avoid this challenge uses organic solvents due to their widened electrochemical stability window and higher solubility potential to form higher, more desirable energy densities. In the synthesis of these organic solvent systems, the conductivity, solubility, viscosity, and stability of the compounds are critically important to the effectiveness of the overall battery systems. In this research, alkyl chains were attached to 4-hydroxy-2,2,6,6-tetramethylpiperidin-1-oxyl (OH-TEMPO), synthesizing different ether derivatives of OH-TEMPO. Constructing a method of purification, OH-TEMPO derivatives were isolated with higher clarity and analyzed by spectroscopy. The pure compounds were used in sodium dodecyl sulfate microemulsions and the microemulsions' electrochemical properties were analyzed. Through deeper understanding of the properties of these derivative compounds and the way they act in organic solvent systems, tailored organic solvent systems can be synthesized to maximize the energy density and stability for RFBs for storing excess energy produced by energy grids.

Poster #12

WBG Devices-Based Matrix Converter for 3-Phase AC to DC Conversion in Industrial Computing Applications

Jack Alagood, Kyle Bedrich, Ian Farrar

Faculty Advisor(s): Dr. Prasad N. Enjeti

A devices-based 3x1 matrix converter is proposed for high voltage power delivery to industrial-scale computing operations such as AI model training, cloud computing, and crypto mining. The system described in this report aims to reduce the energy burden of these loads by improving the power distribution efficiency. The project can be split into three key parts: a primary side matrix converter, secondary side transformer, and an external controls system. The device begins with a matrix converter, which accepts a low frequency three-phase (3Ï•) AC signal and outputs a high frequency one-phase AC signal. The matrix converter consists of three wide-bandgap (WBG) bidirectional switches with gallium nitride (GaN) FETs and is juxtaposed with input/output inductor-capacitor (LC) filters. A high frequency step down transformer then transitions the signal to DC. This secondary side is composed of WBG silicon carbide semiconductors operating as switches in a rectifier. A LC filter reduces ripple in the rectified output. The controls subsystem contains the logic and hardware necessary to switch the gate drivers for the GaN FETs. It utilizes PowerSim to create the logic circuit from PLLs, sine wave and PWM signal generators, and digital logic. For control I/O, a TI F28397D controlCARD is used to handle the switching algorithm and to output the PWM signal to the gate drivers.

Poster #13

BANG, What it Means to be Human in a Universe Without Any

Angel J. Aparicio Sanchez

Faculty Advisor(s): Prof. Sam Woodfin

Nearly 500,000 years into the future, a God-like being by the name of Shivan decimated the human empire known as the Stellar Coalition in a long and arduous war that spanned 200 years. Following its defeat, the citizens of the coalition were transformed into a myriad of genetically modified creatures and given appropriate terraformed worlds for their new needs; this would earn Shivan title of "Deviser" amongst those that could speak. After millenia of observation Shivan abandoned the modified creatures and their worlds in search of new life in a distant Galaxy, but now after 200,000 years of absence, he has returned again to reclaim the worlds of those once conquered. Will the changed humans remember who it was that made them? Will their humanity remerge despite their ghastly changes? What does it mean to be human, even when none are left? This epic, spanning thousands of years, puts to the test how we could survive as a species, even if it is just preserved as a distant spirit. This exhibit includes a short comic, alongside sketches from the notebook of a character within the story, and concept art. The sketches encompass the modified creatures throughout their years of progress and change, alongside Shivan and the rest of the "family".

Poster #14

The Blurring Boundaries between Advocacy and Surveillance: The Use of Biometric Identification Technologies on Refugee Populations

Abigail Owen

Faculty Advisor(s): Dr. Maddalena Cerrato, Dr. Apostolos Vasilakis

This study analyzes the relevancy and efficiency of the metaphors of surveillance presented in canonical science fiction works, specifically Zamyatin's We and Orwell's Nineteen Eighty-Four. These metaphors continue to shape society's response to disruptive technologies and the policies passed to govern them. Zamyatin's and Orwell's surveillance metaphors center around technologies of nondiscriminating surveillance implemented by the state upon the body politic so as to publicly promote unity while ultimately driven by the pursuit of control. As a result, the policy framework they shape fails to categorize the use of biometric identification on refugee populations by NGOs as surveillance. Failing to characterize these instances as surveillance obscures the implications of this technology on the agency of an already vulnerable population, especially when these mechanisms of surveillance are implemented by groups largely considered some of the few remaining advocates for refugees. Breaking from the notion of surveillance popularized in society by seminal science fiction, humanitarian groups and aid organizations serve as actors of surveillance, alongside the state. Their implementation of biometric identification systems on asylum seekers and refugees, furthermore, rather than making any claim to unify refugees with the body politic, serves as a dangerous and irremediable marker of their status as Other.

Poster #15

Customized Synthetic Materials for 3D Printed Cardiac Surgical Model Applications

Jack A. Esche

Faculty Advisor(s): Dr. Anne-Marie Ginn-Hedman

Recent studies have shown that the use of cardiac surgical models improves patient outcomes and decreases the time a patient is in surgery. The option to practice on a custom 3D printed cardiac model allows a surgeon to go into surgery better prepared and with greater confidence so that errors can be avoided. Synthetic materials, including hydrogels, have been used to create these custom synthetic 3D cardiac models for surgical training. However, the use of hydrogels in these models is not optimal due to production challenges, storage requirements, high cost, and customizability restrictions. This study aims to find an alternative synthetic cardiac material to hydrogels that can be easily 3D printed with minimized cost, minimal special storage requirements, and increased material customizability. A wide selection of synthetic materials, including TPU and Plastisol, will be tested for their mechanical properties to compare quantitatively to the mechanical properties of fresh cardiac tissue. Mechanical testing will include shore hardness, puncture resistance force, suture retention, and cut force. With a suitable replacement selected, a 3D printer will be optimized for compatibility in printing the synthetic cardiac tissue material. Preliminary testing and results show Plastisol as a potential leading replacement

for fresh cardiac tissue, although further testing is required. The development of a specialized synthetic cardiac tissue material will improve access to customized cardiac surgical models, benefiting patient and surgeons through improved surgical outcomes and decreased surgical time.

Poster #16

Drug Delivery via Albumin Nanoparticles Incorporated in PEG/Shape-Memory Foam Composite Biopsy Sealants

Ethan VanDever

Faculty Advisor(s): Dr. Daniel Alge

Screening for lung cancer is critical for detecting the disease in its early stages, allowing for earlier treatment. Commonly, a biopsy is performed, during which a surgeon takes a tissue sample from the patient's lung. It is important to seal the hole left by the biopsy in order to avoid pneumothorax, or collapsed lung, or general air leakage in the lung. To do this, a biopsy sealant is implanted at the sample site, which is frequently made of a hydrogel. This project aims to incorporate chemotherapeutic-loaded albumin nanoparticles into a hydrogel and eventually a PEG/shape memory foam composite biopsy sealant. By incorporating chemotherapeutics into the biopsy sealant, treatment can begin immediately, potentially addressing cancerous cells early and preventing progression. Diagnoses of cancer often follow a long waiting time after the biopsy, which can leave a substantial amount of time for the cancer to develop. Furthermore, lung cancer has a high mortality rate, so it is imperative to treat it as soon as possible. It is common for biopsy sealants to be made from hydrogels, such as PEG, and some sealants are made of composites as well. However, biopsy sealants on the market do not deliver chemotherapeutics upon insertion. The first step of this project is to create and characterize the size and stability of human serum albumin (HSA) nanoparticles (NPs) using dynamic light scattering (DLS). Once this is done, a hydrophobic model drug will be loaded into the NPs, and its release kinetics will be quantified by measuring the concentration of the free drug particles in solution at different time points using UV spectroscopy. With the release kinetics modelled, the NPs will then be incorporated into a polyethylene glycol (PEG) hydrogel, and its degradation characteristic

Poster #17

Biological Snowfall: Analyzing Marine Snow Structural Anatomy

Dylan Buchmiller

Faculty Advisor(s): Dr. Antonietta Quigg, Dr. Chen Xu

Much like delicate snowfall, marine snow forms intricate, layered structures composed of organic matter and microbes, playing a critical role in the ocean's carbon cycle through enhanced carbon sequestration. Marine snow is defined as the macroscopic aggregates (greater than 500 micrometers) of phytoplankton, bacteria, detrital material, minerals, and polymeric materials. The latter falls into two

classes: extracellular polymeric substance (EPS) and transparent exopolymer particles (TEP). EPS (both polysaccharides and proteins) and TEP (polysaccharides) are operationally defined, and reflect measurements of different components of the polymeric milieu. This research introduces a novel staining technique that combines Concanavalin A, Alcian Blue, and DAPI to visualize and quantify each component within marine snow aggregates. This developed method addresses the limitations of previous research by providing an enhanced view of individual aggregates. Key objectives include determining the relative areas and proportions of EPS, TEP, and bacteria within aggregates and comparing them with surrounding seawater both before and after marine snow formation using roller tanks. Furthermore, this approach facilitates comparative studies across different environments, such as pelagic and neritic zones, as well as seasonal variations. The visual results will also serve to validate traditional spectrophotometric methods. Ultimately, this research aims to enrich future modeling efforts by incorporating more precise parameters related to microbial interactions and marine snow.

Poster #18

Maximum Flow in the Language of Linear Algebra

Darin Peries

Faculty Advisor(s): Dr. Timothy Davis

The Push-Relabel algorithm was introduced, by Andrew Goldberg and Robert Tarjan, as an alternative way to compute the maximum flow through a network of nodes with edge capacities. It makes use of a novel labeling system and a concept called pre-flow to push units of flow. One of the key features of this algorithm is its ability to be parallelized, as it can move units if flow in almost wave-like patterns, almost like a parallel breadth-first search. A modern-parallel version of this algorithm was developed by Baumstaurk et al. in 2015. This algorithm makes use of atomic operations, queues, and multiple processors to achieve a significant performance increase. However, we believe that the algorithm can be computed in a more simpler fashion using the GraphBLAS standard.

Poster #19

Exploring the Regional Concept of Wellbeing in Florence, Italy Using Cultural Consensus and Consonance Analyses

Laura Anderson

Faculty Advisor(s): Dr. Allison Hopkins

The concept of wellbeing differs between individuals, communities, and cultures. Mainstream wellbeing research aimed at creating social and economic policy focuses largely on measuring standardized dimensions of objective wellbeing rather than building culture-specific models of wellbeing. When compared, these models may be more effective in improving local quality of life for regions with similar subjective concepts of wellbeing. Various methodologies in medical and cognitive anthropology for creating cultural models, or frameworks, using subjective measures within a population have become

widespread. This project yielded an exploratory cultural model of wellbeing for Florence, Italy via analyzing subjective cultural consensus and consonance data provided by English-speaking immigrants and Italians residing there long-term. Data collection was conducted by the 2024 cohort of the A&M Italy Global Health and Lifestyle study abroad program. The questionnaire used to collect this data in Florence, Italy yielded quantitative and qualitative data which was analyzed using UCINET, a cultural consensus analytic software, and methodologies outlined in current cultural consonance literature. This questionnaire was created based on free-list data previously collected and analyzed by the 2023 cohort of the same program. By collecting, consolidating, and analyzing cultural consensus, cultural consonance, demographic, and mental health screening data, this project provides context for a future study involving statistical analysis of the relationship between cultural consonance and mental health in Florence, Italy. Ultimately, this multi-stage project will provide insight into a possible relationship between local subjective wellbeing and mental health.

Poster #20

SuperFuzzer: Merging the Best of Modern Fuzzing Techniques

Stephen Muttathil, Isabel Peedikayil

Faculty Advisor(s): Dr. Jeyavijayan Rajendran

As modern hardware designs grow in complexity, traditional verification techniques such as manual inspection, regression testing, and formal verification become increasingly inefficient. Manual testing and formal verification have proven to be time-consuming and labor-intensive. These methods often struggle to keep pace with the growing intricacy of modern hardware designs, highlighting the need for more advanced and efficient verification solutions. This is especially problematic because there has been an almost exponential increase in the number of hardware vulnerabilities throughout the years. Hardware fuzzing, a systematic technique that iteratively generates inputs and verifies hardware designs for vulnerabilities at the register-transfer level, has become increasingly popular to address some of these challenges. However, existing hardware fuzzers have several limitations. Many are created to tailor specific designs, addressing only individual shortcomings, and therefore lack the flexibility and scalability required to handle diverse RTL designs comprehensively. This lack of universality often results in inefficiencies and reduced effectiveness when applied to systems outside of the fuzzers scope of work. To address these limitations, we propose a novel hybrid framework called SuperFuzzer. This framework integrates elements from various fuzzers to provide a more versatile solution. SuperFuzzer is designed to detect new bugs, achieve high coverage, and overall operate with greater efficiency and effectiveness than existing fuzzers. We achieve this by integrating (i) the diverse mutation and input selection strategies of existing fuzzers such as PSOFuzz and MABFuzz, (ii) the coverage-based feedback of TheHuzz, (iii) formal-assisted input generation of HypFuzz, and (iv) the program generation of Cascade fuzzer. We evaluate and analyze the results of our SuperFuzzer on three open-source processors.

Poster #21

The Evaluation of Liminal Spaces

Jared Slay

Faculty Advisor(s): Dr. Matthew Vess

Previous research has suggested that individuals high in personal need for structure display a higher disliking for modern art relative to individuals low in personal need for structure. This tendency is thought to be related to terror management theory, which states that meaninglessness is threatening to individuals because applying meaning to life is a crucial element for helping to regulate death anxiety. Therefore, heightened mortality salience drives individuals to negatively evaluate meaningless artwork, particularly those with a high personal need for structure. People high in personal need for structure tend to value simple and unambiguous information. This study examined the prediction that individuals with a heightened personal need for structure will have increased feelings of uncanniness and discomfort toward distorted environments when undergoing a mortality salience induction. We recruited 439 participants from Texas A&M University introductory courses. We measured individuals' scores on the Big Five Inventory and Personal Need for Structure. Participants were then randomly assigned to either a control condition or a mortality salience induction. All participants then evaluated several images (i.e., specifically chosen to illicit feelings of uncannyness) on a series of questions (e.g., how uncanny or eerie they think the image is). Our results revealed that mortality salience did not moderate the effect of PNS on individuals' ratings of the images. Replicating previous research, those high in PNS were more likely to rate the images as more uncanny and less appealing. These findings deepen our understanding of how people regulate meaning and how existential concerns may be connected to perceptions of real and unreal environments.

Poster Session 5: 3:30-4:30 PM

Room: MSC 2300 C

Poster #1

GPU Scheduling via Kubernetes

Samuel Bieberich

Faculty Advisor(s): Dr. Stavros Kalafatis

This study aims to fill the research gap in comparative benchmarking of GPU-based scheduling methods via Kubernetes for containerized machine learning (ML) applications. As cloud computing becomes increasingly prevalent for ML workflows and containerization's benefits outweigh those of traditional virtualization, optimizing resource usage remains a challenge for large-scale applications. This research focuses on comparing two open-source GPU scheduling frameworks, KubeShare and Gemini, representing different approaches to GPU scheduling built to interface with Kubernetes environments.

KubeShare focuses on container-level memory allocation via Kubernetes resource quotas, while in contrast, Gemini offers a token-based, dynamic scheduling tool based on kernel burst estimation. The research utilizes MLPerf, an open-source benchmarking suite, to measure performance of ML models across these methods. Diverse ML workloads will be tested to provide a comprehensive comparison of these GPU scheduling methods. This involves setting up containerized environments using Kubernetes and Docker, implementing the KubeShare and Gemini frameworks, and conducting performance comparisons for diverse MLPerf benchmarks. By comparing these approaches, this study will provide insight into their relative strengths and optimal use cases and will offer a replicable and updated workflow for future work. Future steps include expanding the testing to multiple GPU and exploring high performance computing solutions to multiple GPU and exploring high performance computing solutions to better simulate real-world environments. This research has the potential to enhance the efficiency of ML operations in the cloud, enabling greater scaling opportunities for GPU-based exploration of large ML datasets.

Poster #2

Using Software to Simulate and Evaluate MFE on Biological Molecules

Kayal Gownder

Faculty Advisor(s): Dr. Mary McDougall

Magnetic fields are produced when current moves through a conductive medium and exhibit intriguing properties, including their impact on biological systems. Certain migratory species demonstrate magnetoreception, the ability to navigate using variations in intensity in the Earth's magnetic field. Magnetoreception can partly be explained by the radical pair mechanism (RPM) where energy absorption by a molecule leads to excitation, radical pair formation in the singlet state, intersystem crossing, and the mixing between singlet and triplet states as the molecule returns to its ground state. The magnetic field affects the rate at which molecules return to the ground state and, consequently, the rate of reactions. Flavin adenine dinucleotide (FAD), a molecule found in animals that use magnetoreception, fluoresces as it returns to its original state via the RPM; the intensity of fluorescence and the rate of reactions in FAD can be controlled by the magnetic field. Since reaction rates and cellular ATP production are linked, MFEs can theoretically manipulate ATP production, specifically within the mitochondrial Electron Transport Chain. This study utilizes MATLAB to simulate MFE on cells and compares it to experimental data to assess the predictive accuracy of analytical models. Results from the experiments regarding the ability to influence ATP production with the magnetic field could lay the groundwork for potential applications such as treatment that exploits ATP depletion. A single exponential, double exponential, and composite model were evaluated on MATLAB for their accuracy in representing simulated data. The double exponential model outperformed the other models, having a better fit accuracy metric value of -1.5298e-05 compared to 0.0028976 and -1.5303e-05.

Poster #3

Comparative Analysis of Enzymatically Degradable Peptides in PEG-Based Granular Hydrogels with Supermolecular Click Product Interactions

Deven Sterzing

Faculty Advisor(s): Dr. Daniel Alge

Hydrogels are widely used for their highly tunable properties and can be designed for different applications. Gradual stiffening of the extracellular matrix (ECM) is observed in both tissue development and pathologies like cardiovascular disease, and fibrotic disease. In a previous paper, Holt et al. showed that poly(ethylene glycol) (PEG) based peptide-functionalized bulk hydrogels were capable of mimicking the ECM by leveraging inverse-electron demand Diels–Alder tetrazine–norbornene click products (TNCPs). The paper used thiol-ene click chemistry and TNCPs to compare two enzymatically degradable peptides, KCGPQGIWGQCK (KCGPQ-W) and KCGPQGIAGQCK (KCGPQ-A), and showed the hydrogels with KCGPQ-W exhibit a higher stiffness. The objective of this study is to investigate the performance of the two enzymatically degradable peptides on PEG-based granular hydrogels and test if the peptide would exhibit the same trend as bulk gels. In brief, PEG microgels were synthesized by thiol-norbornene click chemistry which reacts 4-armed PEG-amide-norbornene with enzymatically degradable peptides (KCGPQ-A or KCGPQ-W) and cell adhesive peptide (CGRGDS). Then, these microgels were annealed using PEG-tetra-methyltetrazine (4PEG-mTz). The degradation and the storage modulus will be measured to compare the two enzymatically degradable peptides. These granular hydrogels have potential utility in regenerative medicine and clinical testing, and with the ability to be injected into a wound cavity, can be applied to a wide variety of applications.

Poster #4

The Overexpression and Purification of the Integral Membrane Protein GlpG

Matthia A. Klatt

Faculty Advisor(s): Dr. A. Josh Wand

Historically, nuclear magnetic resonance (NMR) experiments exploring the relationship between protein folding/function and conformational entropy (Î”Sconf) have only considered soluble proteins. Integral membrane proteins (IMPs) were less explored than soluble proteins due to expression and purification difficulties. Thus, it is consequential to understand the relationship between Î”Sconf of IMPs and their folding and function. In 2020, the first paper looking at IMP Î”Sconf was published, suggesting that the IMP folded state may be thermodynamically stabilized by Î”Sconf—which suggests that IMPs are an important area of interest. The first step to understanding the relationship between Î”Sconf and IMPs is to be able to overexpress, purify and refold a diverse selection of IMPs that fit the criteria for NMR studies. GlpG from E. coli was chosen for study, due to it meeting the size limitation of NMR and having an established overexpression and purification protocol in the literature. GlpG is an alpha-helical rhomboid-family integral membrane protease, which is different to previously studied proteins. The

function of GlpG is to cleave the trans-membrane domains of other proteins. Affinity, size exclusion, and cation exchange chromatography's were explored as a means to purify GlpG. It was found that additional methods are needed to purify GlpG before it can be studied with NMR—which might include alternative expression protocols and possible protein refolding protocols.

Poster #5

Computationally Light Audio Localization in Robotics

Dennis Binford, Blake Chevalier, Anton Fedotov

Faculty Advisor(s): Dr. Oscar Moreira

Sound source localization (SSL) is a powerful tool for robotic sensory enhancement. The current state-of-art algorithms are computationally expensive and lose accuracy when microphones become closer together; these constraints make audition less viable in smaller robots or in robot swarms. Therefore, this paper explores the viability of using rotating microphones to reduce computations and the minimize the distance of sensory nodes. This paper demonstrates simulated localization scenarios and design choices taken to reduce computations and enhance accuracy. The proposed rotational audio localization method is compared with angle of arrival (AoA) and distance estimation metrics of algorithms in current literature. In addition to simulations, a robot and hardware system was developed to test the proposed localization method, collect data metrics, and research improvements to the algorithm and robot design. Using the proposed localization method, microphone placement was able to be minimized, the micro-controller sampling frequency is reduced, and the computation requirements are significantly reduced while localization error remains comparable to methods in current literature. Additionally, experimentation was done using the robot system to research two behaviors: the impact of microphone directionality on the method's accuracy, and the effectiveness of different rotational algorithms at various distances. From simulation, robot development, and experimentation, this paper illustrates a creative solution to make sound localization more efficacious for robotic applications.

Poster #6

Individual Differences in Willingness to Adopt Plant-Based Diet

Summer Moser

Faculty Advisor(s): Dr. Rebecca Schlegel

Individuals might follow a plant-based diet for a variety of reasons such as environmental concerns, animal rights, or health related motivations. While previous research has examined the relationships between the effectiveness of plant-based arguments and individual differences, there is a lack of experimental evidence. This exploratory study aims to determine which arguments for a plant-based diet are most effective in increasing one's willingness to engage in plant-based diets. Moreover, this study seeks to provide insight regarding these differences in argument effectiveness by examining potential interactions with relevant individual difference variables. Participants first completed the individual difference measures: justice sensitivity, environmental attitudes, and health consciousness

scales. They were then randomly assigned to one of four conditions: (1) Animal welfare arguments, (2) Environmental welfare arguments, (3) Health-based reasons or (4) a control condition (i.e., study habits). They then completed items related to their willingness to engage in a plant-based diet. Main effects of argument type, as well as potential interactions with individual differences relevant to each argument (e.g., justice sensitivity interacting with animal welfare arguments), will be examined. There are no specific predictions for main effects, but we predict that each argument will be more effective for individuals high in the relevant potential moderators.

Poster #7

AI Meets Health Engineering: Machine Learning Approaches for Automated Assessment of Endothelial Health in Bioengineered Cell Systems

Ethan S. Mahalingam

Faculty Advisor(s): Dr. Abhishek Jain

In vitro culture models are valuable tools for gaining biological insights by allowing us to study cellular interactions with other cells, molecules, substrates, etc. Traditionally, the state of cells in such models is evaluated by performing manual morphological inspection using microscopy or through employing cell viability assays. However, these approaches alone possess shortcomings, such as the lack of objectivity in measurements and the requirement for complex cell-labeling procedures. This study integrates artificial intelligence, through the utilization of machine learning, with microscopy and immunohistochemistry to develop a label-free tool to address the need for streamlining in vitro endothelial cell assessment. This study implements an algorithmic approach to develop a computer-vision model that analyzes the phenotype and morphology of vascular endothelial cells at varying degrees of activation, which were cultured and exogenously activated by Tumor Necrosis Factor Î± treatment. This model works by taking a phase-contrast microscopy image of cultured cells, and predicting the normalized expression level for two proteins critically related to vascular endothelial cell activation: Thrombomodulin and Vascular Cell Adhesion Molecule 1. In summary, this model serves as a proof-of-concept for assessing in vitro cellular health using machine leaning, and provides a foundational methodology for developing a repertoire of similar tools to accelerate biological investigations and discoveries.

Poster #8

Examination of the Relationship Between Texas A&M Student Personality and Animals Owned

Alexcia Gaines

Faculty Advisor(s): Dr. Courtney Daigle

Personality plays a considerable role in a person's everyday life, social activity, and overall decision making. Those that are more outgoing may easily make friends and find spontaneous activities exciting,

while those who are more introverted may avoid larger social gatherings and seek routine. Many ways to measure these personalities have been created, from Myers-Briggs to the Big Five; however, all tests acknowledge the many differences in personality. Personalities make people unique, and as such it stands to reason that their preferences in things other than socialization might be unique as well--specifically, their preferences in pet ownership. This research project aims to examine these preferences by comparing an owner's personality to the types of animals they own. It will provide information on the connection between human personality and the type of animal(s) they own, demonstrating whether or not someone's personality can influence which animal they choose as a companion. This is important, specifically for college students who may benefit from the companionship of something they naturally gravitate towards. An animal that meshes well with a person can be a reliable friend in tough times, and many pets have long since been associated with physiological and mental benefits. Being able to match a student's personality to a specific animal type would help strengthen the companionship between them and perhaps further increase the positive effects seen in human-animal interactions. The survey and resulting data will shed light on these topics and help other students choose the right companion animal to get them through difficult occasions.

Poster #9

Characterization of Reporter Proteins in Attenuated Brucella Melitensis

Sima Dib

Faculty Advisor(s): Dr. Chelsea Hu

Bacteria-based cancer immunotherapy uses engineered bacteria to target tumors and stimulate immune responses, offering a promising alternative to traditional cancer treatments. However, its application presents some risks, such as the production of endotoxins and possible off-target delivery. A SPIKE chassis, an attenuated Brucella melitensis Î”vjbR shows great promise as a therapeutic chassis. It lacks endotoxin activity and naturally accumulates in the tumor, allowing a safer platform to engineer. Despite these advantages, the strain lacks a robust synthetic biology toolbox for the chassis. The toolbox enables the construction and optimization of genetic circuits that promote the performance of specific functions. Genetic circuits can have many components, such as promoters, ribosomal binding sites, terminators, and reporter proteins. Reporter proteins are encoded by a reporter gene and produce a measurable signal, such as fluorescence or color change. This protein aids researchers in monitoring gene expression and cellular processes. In this study, we characterized seven reporter proteins in this chassis. Using the 3G assembly method, genetic cassettes containing the reporter proteins were constructed. All the reporter proteins tested were successfully expressed in SPIKE, with eGFP, sfYFP, and sfCFP displaying the highest fluorescence levels with minimal bacterial autofluorescence. These findings further the development of the genetic toolbox for Brucella melitensis Î”vjbR, allowing further application in synthetic biology and advancing the field of bacteria-based cancer immunotherapy.

Poster #10

Activity Classification in Obfuscated Enviornments

Joshua Mayhugh

Faculty Advisor(s): Dr. Tracy Hammond

This project focuses on developing advanced pre-processing methodologies for live video human-activity recognition models, specifically addressing the unique challenges posed by the variability in children's motor skills. Recognizing that children exhibit diverse and evolving movement patterns, the research aims to create robust models that can accurately interpret and analyze their activities. The methodology involves collecting video footage of young swimmers in various environments and implementing sophisticated pre-processing techniques such as frame extraction, normalization, noise reduction, and data augmentation. These steps are essential to enhance the quality and consistency of the data, ensuring it is well-suited for effective model training. The project will evaluate several selected methodologies and neural network architectures to determine which are most proficient at understanding and classifying activities unclear environments. By leveraging cutting-edge Computer Vision libraries like YOLOv8 for object detection and SAM2 for segmentation, the preprocessed video data will be utilized to train models capable of distinguishing between different swimming strokes with high accuracy. The expected outcome is a highly accurate and reliable classification system that provides personalized feedback to young swimmers, helping to enhance their techniques, reduce the risk of injuries, and improve overall performance. Furthermore, this system aims to support coaches and trainers by offering actionable insights based on detailed motion analysis. Beyond its immediate application in swimming, this work contributes to the broader field of motion recognition in sports science and promotes a more inclusive approach to athletic training.

Poster #11

Localization of DGAT2 from the Endoplasmic Reticulum to Lipid Droplets

D'Marco De Leon

Faculty Advisor(s): Dr. Xuewu Sui, Dr. Hongrui Zhang

Triacylglycerols are lipid molecules that store energy in cells. The final step of triacylglycerol (TG) synthesis is catalyzed by the enzyme family diacylglycerol acyltransferase (DGAT). In this project, we explored the localization of the enzyme diacylglycerol O-acyltransferase 2 (DGAT2) from the endoplasmic reticulum (ER) to the lipid droplets (LDs). DGAT2 is synthesized in the ER and migrates from the ER to the LDs. DGAT2 can exist in both the endoplasmic reticulum (ER), which is a part of the microsome, and the lipid droplets (LDs), which are part of the fat layer. We determined and compared the activity of DGAT2 in both the microsome and the fat layer using a C-14 labeled activity assay. After normalization, the fat layer showed higher activity than the microsome. This suggests that once DGAT2 migrates to the LD, it undergoes a conformational change and becomes more active, producing more triglycerides. These results show that DGAT2 is a versatile enzyme, being able to move from the ER to the LD after being synthesized, becoming more active in the new location. Understanding more about

the localization of DGAT2 from the ER to the LD can provide a useful model for localization of other proteins onto the LD surface.

Poster #12

Efficiency Calibration Procedure of a High Purity Germanium Gamma Ray Detector for the Astatine-211 Production at the Cyclotron Institute

Alexandra Tabacaru

Faculty Advisor(s): Dr. Sherry J. Yennello

Accurate activity determination of astatine-211, a promising alpha-emitting radioisotope for targeted cancer therapy, is essential for its safe and effective medical use. Achieving this accuracy requires a reliable and precise efficiency calibration process. This study addresses these challenges by developing separate efficiency calibration curves for high and low energy ranges, utilizing standard gamma-emitting sources such as europium-152, barium-133, cesium-137, and manganese-54. These tailored calibration curves were designed to improve the accuracy of activity measurements by accounting for energy-specific variations in detector efficiency. The results demonstrated that activities calculated using high-energy calibration curves had significantly smaller percentage differences compared to those obtained with a single curve spanning the entire energy range. This highlights the limitations of a broad-spectrum calibration approach for isotopes with complex energy distributions. Additionally, the attenuation effect of T-Flex shielding material was carefully quantified and corrected to ensure precise activity determination. By addressing these factors, the study provides a more robust methodology for measuring astatine-211 activity. This work underscores the critical importance of energy-specific efficiency calibration in the accurate determination of astatine-211 activity, paving the way for more reliable and reproducible measurements that can support its broader application in targeted alpha therapy.

Poster #13

In vivo Investigation of Network Hyperexcitability One Month after Traumatic Brain Injury

Ethan Maclam

Faculty Advisor(s): Dr. Punam Pokam

Traumatic brain injury (TBI) affects approximately 1.7 million individuals annually in the U.S., resulting in 52,000 fatalities. Clinically, TBI is associated with excitability events such as seizures and spreading depolarizations, which worsen outcomes. While animal models of severe TBI demonstrate neuronal hyperexcitability and seizures one month post-injury, it remains unclear if similar changes occur following moderate TBI. Furthermore, the impact of TBI on long-term potentiation (LTP), a key mechanism of synaptic plasticity critical for learning, memory, and information storage remains poorly understood. Since cognitive impairments are common in TBI patients, understanding changes in

hyperexcitability and plasticity one month post-TBI is essential to uncover the mechanisms underlying these deficits. This project investigates whether moderate TBI disrupts hyperexcitability and plasticity to guide the development of future therapeutic strategies. Using 2-photon microscopy and the genetically encoded calcium indicator Synapsin-GCaMP8m, we assess calcium signaling, which reflects excitatory synaptic transmission, during cortical activity and synaptic plasticity in adult male mice (2–3 months old) subjected to controlled cortical impact (moderate TBI) or sham injury. We hypothesize that TBI increases excitability and LTP, as evidenced by elevated calcium peak frequencies and amplitudes during spontaneous activity, whisker sensory-evoked activity, and a sensory-evoked LTP paradigm in awake mice. These findings would provide evidence of network disruptions following TBI. Future experiments will focus on examining the cellular and synaptic mechanisms, including excitatory/inhibitory transmission, that contribute to changes in excitability and plasticity after TBI.

Poster #14

Asymmetric Offner Relay Spectrograph

Evan Batteas

Faculty Advisor(s): Dr. Darren Depoy, Dr. Jennifer Marshall

Spectrographs are a key instrument in astronomical observation. They spread out incoming light into its component wavelengths. Analyzing the spectra produced by spectrographs can tell us the elemental composition of what we are looking at, which can provide context clues to help us figure out how old an object is, how far away it is, and if a planet may contain life. These clues come from the emission and absorption lines in the spectra we are observing, and the wavelengths where they sit. A long slit spectrograph is designed and assembled, utilizing an asymmetric Offner relay. The parts chosen to create the relay are all sourced from commercial retailers, in order to increase the availability and reproducibility of this spectrograph design. The spectrograph is designed to utilize 3D printing in its construction, in order to further ease the difficulty of sourcing parts for construction, and is designed for mounting on a C14 Celestron telescope. While a typical Offner relay contains only two spherical mirrors, one concave and one convex, an asymmetric Offner relay contains three spherical mirrors, two concave, one convex. Due to the asymmetry of the Offner relay, an accessible pupil is formed, where a grating is placed to disperse the light. The light is then collected with an SBIG STF-8300 CCD. In order to facilitate the positioning of the instrument on the proper target, a guide camera is made use of, placed before the slit and fed light with a 50/50 pickoff beam-splitter. As a backup, the grating is rotatable to 0th order.

Poster #15

Effects of ECG Representation Learning on Multimodal Models

Matthew Wang

Faculty Advisor(s): Dr. Bobak J. Mortazavi

During a patient's stay in the hospital, various different metrics are taken for medical professionals to analyze. Such metrics include data such as ECG(wavelength data), Notes(annotation data), and medical time-series data. These metrics have shown promise through different deep learning techniques. However, many challenges arise when solely trying to use these deep learning techniques.The first issue arises is that there is a need for a significant amount of labeled data. This issue can be solved by training with the contrastive objective in mind. With the contrastive method, we are able to pair different modalities together and eliminate the issue of having to need a large dataset with many labels. However, with medical stays producing so many different modalities of data, our current techniques using contrastive learning isn't enough. One issue with contrastive learning is when more modalities are added, it exponentially increases the complexity and compute times for training the model. Thus, we use a relatively novel idea, ImageBind, and alter it for this specific use case. This approach takes the idea of ImageBind, binding different modalities through the image modality, and instead of using image as the common medium, notes are instead used to bind the three modalities together. After pretraining, our tasks are evaluated on downstream tasks of in hospital mortality, post discharge mortality. This is done through a combination of the MIMIC-IV and PT-XBL datasets in order to get testing data on all combinations of modalities. We see significant improvement in comparison to previous models. We use several different testing metrics, AUCROC, Zero-Shot, and a Linear Evaluation.

Poster #16

Novel Approach to Trichrome Staining for Tissues Embedded in Plastics

Nathan Cole

Faculty Advisor(s): Dr. Staci Jessen Horn

Through specialized staining, pathologists can evaluate tissues on microscope slides. In the evaluation of medical devices, Masson's Trichrome, a red-blue stain, is often used to assess the extracellular matrix and fibrous capsule surrounding the device to determine its safety and biocompatibility. For devices composed of hard materials, paraffin histology is not suitable. Embedding tissues with these devices in plastic offers an alternative to determine host response on a microscopic level. However, plastic embedding can provide staining challenges with inconsistent staining results. The purpose of this study was to create a new method for staining tissues embedded in plastic with Masson's Trichrome. Using techniques developed at the Cardiovascular Pathology Lab, histology slides of pig aorta embedded in plastic were created. A base protocol was created based off processes used in paraffin histology. Methods to improve staining quality included increasing staining times, switching chemical order, adding etching steps, introducing heat, and varying etching procedures. Verification of the procedure involved repetition of the protocol on other collagen rich tissues. Adding heat to the Aniline Blue increased the permeation of the dye for collagen. Of the tested etching methods, placing the slide in 2%

formic acid solution and 50% ethanol in series resulted in greater coloration of the tissue. Changes in the staining order decreased color differentiation. Through the combination of heat, additional time, and etching, the developed stain allowed for consistent staining of collagen and extracellular matrix of the tissue. Applying this staining technique to medical device studies will provide enhanced evaluation of the device's biocompatibility and overall safety.

Poster #17

Design of a 3-D printed Free-Space Permittivity Measurement Setup at Microwave Frequencies

Jacdon Green, Braden Box

Faculty Advisor(s): Dr. Arya Menon

This design extracts the permittivity of a material in free space at 10GHz. Error introduced by diffraction and reflection are mitigated by a lens that collimates the beam, allowing for Gaussian approximation. Free space measurements allow non-invasive material characterization and reduced sample sizes. The setup employs at minimum a pair of rectangular horn antennas, a sample, and a VNA for measurement; the horn antennas are symmetric about the sample and the use of two additional dielectric lenses improves measurement accuracy. Simulation results are used to verify the operation of the lenses and to ensure the beam is confined to the sample radius. Samples consist of non-metallic ceramics of varying dielectric constants, thickness, and sizes. Constructed from 3D printed components for rapid development, the setup generates an environment where the scattering parameters of a material-under-test are isolated and measured; error introduced by the ambient environment and reflection from the setup are large, however, post processing the initial calibration substantially improves accuracy and reliability since the measurements are taken along with the calibration standards. Additional lens types are tested, and the results compared to the material datasheets provided by manufacturers. Each lens is printed with different levels of quality in order to evaluate their performance in non-ideal circumstances.

Poster #18

Effects of Induced Pluripotent Stem Cell Astrocyte Derived Extracellular Vesicles on Short- and Long-term Hippocampal Neurogenesis

Alexandra Morton

Faculty Advisor(s): Dr. Ashok K. Shetty

This study investigates the effect of extracellular vesicles (EVs) derived from human-induced pluripotent stem cell (hiPSC) astrocytes on hippocampal neurogenesis in mice models. EVs are known to contain neurotrophic factors and signaling molecules critical for neurogenesis. Using a novel intranasal administration route, this research evaluates the effects of EV treatment on the expression of doublecortin (DCX), a marker for immature neurons, to quantify neurogenesis. Four groups of mice were

analyzed: two treated with astrocyte-derived EVs and two control groups receiving phosphate-buffered saline (PBS). Each treatment was administered twice, with one experimental and one control group evaluated at two months post-treatment and the remaining groups at 12 months. Results indicate a significant increase in DCX-stained neurons in groups treated with astrocyte-derived EVs compared to controls, highlighting the potential of these vesicles to enhance neurogenesis in the hippocampus. These findings suggest that EVs may play a critical role in developing non-invasive therapeutic approaches for neurodegenerative diseases. This study underscores the relevance of astrocyte-derived EVs in promoting hippocampal plasticity and provides a foundation for future research into their mechanistic pathways and clinical applications.

Poster #19

NF-κB-Inducing Kinase (NIK) in Astrocytes Drives Systemic and Local Inflammatory Responses in Male Mice

Sriya L. Gourammagari

Faculty Advisor(s): Dr. Raquel Sitcheran

Astrocytes, the most prevalent glial cells in the central nervous system (CNS), are crucial for maintaining neural health and homeostasis. Their dysfunction is linked to various neurological disorders. Under pathological conditions, astrocytes can switch to either proinflammatory, neurotoxic (A1) or anti-inflammatory, neuroprotective (A2) states, influenced by changes in cytokine signaling and gene expression. NF-κB-Inducing Kinase (NIK), a key regulator of the NF-κB pathway, is highly expressed in astrocytes and is thought to play a central role in modulating astrocytic responses to inflammation. However, the exact function of NIK in astrocyte-driven inflammatory processes is not fully understood. This study examines the role of NIK in regulating local and systemic inflammatory responses to lipopolysaccharide (LPS)-induced inflammation using astrocyte-specific NIK knockout mice (GFAP-KO). Both male and female mice were administered LPS, and brain and liver tissues were collected after 24 hours. Quantitative PCR was used to assess the expression of astrocyte markers (GFAP, S100B, GLT1), proinflammatory markers (TNF-α, IL-6), and the anti-inflammatory marker IL-10. The results show that NIK influences inflammatory and astrocytic responses to LPS in a sex-dependent manner. In female liver tissues, LPS treatment led to decreased expression of TNF-α, IL-6, and IL-10 in NIK (GFAP-KO) mice compared to controls, while male mice showed increased TNF-α expression. In the brain, both sexes displayed increased TNF-α and IL-10 mRNA levels post-LPS. These findings suggest that NIK plays a critical, sex-specific role in regulating astrocytic responses during inflammation, highlighting its potential as a therapeutic target for neurological disorders linked to astrocyte dysfunction.

Poster #20

Direct User Control of Knee Exoskeletons

Zachary Bucknor-Smartt, Javid Mustafa, Landry Graves, Willem Bannick, Mamtora Korwani

Faculty Advisor(s): Dr. Gray Cortright Thomas

Mobility impairments affect a significant portion of the population, leading to reduced autonomy and quality of life for millions of individuals. To address this challenge, modular assistive devices have gained attention as a means of providing users with partial physical assistance to enhance mobility. However, existing solutions are often limited by control systems that fail to account for real-time user input, resulting in inefficient and non-adaptive torque assistance. Additionally, current designs frequently suffer from mechanical shortcomings such as slippage and discomfort during use, hindering long-term adoption. Previous work has focused on the development of customized user-torque patterns based on biomedical parameter optimization, yet these methods do not take direct user preference into account. In this paper, we propose a novel framework for direct user control of a knee exoskeleton, enabling users to dynamically modulate torque assistance based on intuitive control signals during movement. Our approach leverages user-generated input signals to adapt torque profiles in real time, improving both the overall effectiveness of the exoskeleton system. In addition to the control framework, this paper introduces key hardware improvements to address slippage and stability issues commonly observed in current lower limb exoskeleton designs. These enhancements include the integration of a constant length belt tension system and a handheld controller for user inputs. The proposed framework and hardware upgrades are validated through a series of human subject trials. This study highlights the potential of customizable lower limb assistive devices to transform rehabilitation practices and improve the quality of life for individuals with mobility challenges.

Poster #21

CPU Optimization for Training Large Language Models

Griffyn Young, Rishikesh Prasad, Bailey Faulk

Faculty Advisor(s): Dr. Stavros Kalafatis

Artificial intelligence (AI) is on the rise, and its applications are expanding across various fields. Among AI technologies, large language models (LLMs) are becoming increasingly prevalent. However, training these language models on massive web-based datasets can take weeks or even months. Our goal is to determine the performance bottlenecks for general-purpose central processing units (CPUs) running LLM training workloads and optimize microarchitectural components of the CPU to boost its performance speed when running these workloads. To achieve this, we must first identify the representative workloads. While it may seem sufficient to label these workloads as 'AI workloads', that alone does not capture the complexity. Training and optimization differ significantly for models designed for image recognition as opposed to natural language processing (NLP) tasks. The training model we will be using for data collection and optimization is a long short-term memory (LSTM) model. Since language models are our focus, we will use a workload tracing software to capture instruction-level traces of the training workload, and run the traces through ChampSim, an open-source trace-based simulator for

microarchitectural study. From there, we will gather performance data and analyze sources of inefficiencies.We will mainly concentrate our study in branch prediction, prefetching into cache, cache size, replacement policy, frequency range, and double data rate (DDR) speed. We will optimize the CPU configurations in these areas and rerun our original traces through ChampSim to evaluate performance improvements. Instructions per cycle (IPC) will serve as a baseline metric in determining overall performance, in addition to other performance statistics provided by ChampSim

Poster #22

"The Land!": An Analysis of the Native American Remains Held by Texas A&M

Megan E. Williams

Faculty Advisor(s): Dr. Heather Thakar

Since the passing of the Native American Graves Protection and Repatriation Act in 1990, federal law has dictated that any collection receiving federal funds, such as museums and public universities, must return any and all Indigenous remains and associated funerary items to their rightful tribe. Combined, the remains of over 110,000 Native Americans are held in institution's storage closets across the United States, with around 150 at Texas A&M University. While the prospect sounds relatively simple, some anthropologist and university officials have struggled to relinquish control of the remains and funerary objects, often citing a lack of funding as the culprit. This research aims to provide clarity about the individuals that make up Texas A&M's NAGPRA collection and create a database about each set of remains to actively increase repatriation efforts. Using archaeological site reports, the Federal Register, and other documents, the research will be a concise summary of the Native peoples currently being held by Texas A&M. Additionally, this research will also create conversations about Texas A&M's relationship with NAGPRA and how the university plans to support repatriation efforts.

Poster #23

Childhood and Horror: Exploring the Allure of Halloween in RPG Gaming

Savannah Higgins

Faculty Advisor(s): Prof. Samuel Woodfin

This paper will delve into the personal, aesthetic, and historical motivations for what I will present as a visual slice for a Halloween-inspired horror RPG with a young demographic. I will discuss my own childhood experiences with scary stories, movies, and video games and how they have affected not only my taste in media, but also my personal style in terms of art and game development. I will point to several prime examples of child-friendly horror films such as the popular stop-motion movies The Nightmare Before Christmas, Coraline, and Paranorman, particularly the critical reaction to the latter two and the argument amongst critics over whether they are suitable for children at all by the standards of the ratings system designed by the Motion Picture Association, parallels of which will be drawn with the Entertainment Software Ratings Board system. On the other end of the spectrum, so called Mascot Horror video games such as the popular Five Nights at Freddy’s and Poppy Playtime franchises will be

used as examples of potentially child-unfriendly media due to auditory stimuli and gruesome imagery. For historical inspiration, I will be looking at the histories of both the Celtic roots of Halloween and the traditions and iconography associated with it, and the role-playing game genre, explaining potential aesthetic and even conceptual overlap between them and how the choice of genre will play into the phenomenon of child-like media that is designed to scare and frighten, yet teach and empower young children.

Poster #24

Enhancing User Interaction and Data Visualization in High-Performance Computing Dashboards

Victoria Chen

Faculty Advisor(s): Dr. Frank Shipman, Dr. Meng Xia

This study focuses on enhancing user interaction and improving data visualization within high-performance computing (HPC) dashboards to enhance computational research and operational efficiency in scientific and engineering domains. HPC systems are critical to solving complex computational problems across a variety of disciplines, yet the accessibility and usability of their dashboards often fall short of meeting the needs of a diverse user base. Recent advancements in Human-Computer Interaction (HCI) and usability research provide valuable insights into designing interfaces that significantly improve user experience, system utility, and overall efficiency. These advancements underscore the importance of creating intuitive and user-friendly tools to support users in navigating increasingly complex systems. This study aims to address this gap by conducting a structured user study to gather comprehensive feedback from current users of the Texas A&M High Performance Computing Center (HPRC) dashboards. By understanding existing user perceptions and identifying usability challenges, the study seeks to integrate these insights into the dashboard design process, ultimately improving usability and lowering barriers to entry for potential new users. The anticipated outcomes include enhanced functionality, user-friendliness, and broader adoption of HPC systems.