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A Comparison of MuDst and PicoDst data Analysis Methods

Seth Hall

Faculty Advisor: Saskia Mioduszewski, Ph.D.

The STAR Experiment at Brookhaven National Laboratory (Solenoidal Tracker at the Relativistic Heavy Ion Collider) collects an enormous amount of data from heavy-ion collision experiments. Previously, the Micro-Dst (MuDst) data format was used for analysis with ROOT-based software. In 2018, a new format was implemented, called PicoDst, which keeps only the most relevant experimental data to reduce memory consumption. However, the PicoDst format is incompatible with existing analysis software, and also discards some of the data this software depended on. This paper considers the fundamental differences between MuDst and PicoDst, and whether there is any existing analysis software that cannot be re-written to work with PicoDst, on account of necessary experimental data excluded by the new format.

Subjects: Science (STEM)

A Computer Vision and Maps Aided Tool for Campus Navigation

Alexander Hall

Faculty Advisor: Shinjiro Sueda, Ph.D.

Current study abroad trips rely on students utilizing GPS directions and digital maps for navigation. While GPS-based navigation may be more straightforward and easier for some to use than traditional paper maps, studies have shown that GPS-based navigation may be associated with disengagement with the environment, hindering the development of spatial knowledge and the generation of a mental representation or cognitive map of the area. If one of the outcomes of a study abroad trip is not only to navigate to the location, but also to learn about important features such as urban configurations and architectural style, then there needs to be something better than students exclusively following GPS directions.

Literature in urban design and planning has emphasized the importance of environmental features in spatial cognition. Environmental features such as landmarks and paths aid to form the foundation for a user's cognitive map and improve spatial knowledge acquisition. In contrast to a wayfinding mobile application relying solely on GPS-based navigation, the introduction of a context-awareness feature which facilitates an interaction with the environment may serve to promote spatial cognition.

As such, this research introduces the mobile application, TAMU Building Seeker which I have developed to serve this purpose. In addition to GPS-based navigation, this mobile application contains a contextual awareness feature being the ability to take photos of various buildings and landmarks at Texas A&M University and retrieve information on the building recognized in the image. This involved the construction of an image classification model using more than 4,500 images of over 30 buildings and landmarks around campus. The accompanying image dataset has been made publicly available on Google Drive for use in general applications.

Following the development of the mobile app, a user study was conducted to determine the effects of the presence or absence of GPS-based navigation and the building recognition feature on spatial cognition.

While this study and mobile app were limited to the Texas A&M campus, they can be applied to a wide range of settings from a global study abroad program in an unfamiliar location to general use in wayfinding applications.

Subjects: Social and Behavioral Sciences, Technology (STEM)

A Metric for Intrinsic Motivation in Reinforcement Learning Agents

Yasin Alam

Faculty Advisor: Yoonsuck Choe, Ph.D.

Classically, the reward for an agent is given by extrinsic factors which motivate the agent to improve and learn; however, an active area of research within cognitive science and AI is the effect and necessity of intrinsic motivation for an agent. This can manifest itself in many forms from curiosity to reduction of cognitive dissonance to motivation for effectance. Despite the prevalence and perceived importance of intrinsic motivation, there is no metric to measure “how” intrinsically motivated an agent is compared to another and is instead, largely empirical. Furthermore, methods that might be stated to be intrinsically motivated can be directly linked to the environment and thus, might be less intrinsically motivated than thought. Thus this thesis presents a general metric for intrinsically motivated agents to suggest that highly intrinsically motivated agents are more robust than less intrinsically motivated agents. First, an overview and review of reinforcement learning and intrinsic motivation is presented. Following this, a general metric is proposed with empirical and mathematical justification to measure the intrinsic motivation of an agent. Lastly, several intrinsic motivation algorithms are tested in different environments to evaluate the metric and compare the relative performance of the agents.

Subjects: Engineering (STEM), Science (STEM)

Active Filtering for Grid Connected PV Farm Systems

Salmi Ranpatabendi

Faculty Advisor: Prasad Enjeti, Ph.D.

In this thesis a topology of an active LCL filter is developed to mitigate harmonics in grid-connected renewables. A proposed active inductor is used to replace the grid side inductor of an LCL filter. The active inductor is expected to emulate an inductance in a smaller footprint using a Voltage Source Inverter (VSI). The VSI consists of an H bridge, a small passive inductor and a DC link capacitor. To control the proposed active inductor a two loop control is used. The inner loop consist of Hysteresis control to shape the current of the VSI in such a way that the current of the converter emulates the current of an inductor. Additionally, the outer loop of the control is in charge to regulate the DC voltage of the VSI to an specific value. The design is expected to address emerging challenges in size and cost of LCL filters while meeting the IEEE 519 - 2014 standards. This design will provide a more compact filter compared to passive LCL filters used in conventional PV farms. A prototype of the active inductor is built using Gallium Nitride switches to reduce switching losses. The design is tested with 60 Hz, 1 kHz and 6 kHz for sine wave and square wave input voltages in simulation and hardware. A resistor was connected in series with the inductor to protect the design from current overshoots. The emulated inductance is lowered as the frequency increased to have current ripple in 5A - 10A range to observe the behavior of the system properly.

Subjects: Engineering (STEM)

AI Approach for Diagnosing Aortic Graft Infections in PET Images

Ayesha Siddiqua Afsar Mohammed Azimuddin

Faculty Advisor: Othmane Bouhali, Ph.D.

This study aims to utilize an Artificial Intelligence approach to diagnose graft infections in PET images. Diagnosis of aortic graft infections has been a struggle and because of its high morbidity and mortality, early identification of AGI is critical for immediate treatment. The primary objective is to improve the process of diagnosing graft infections by finding a diagnostic ability for AGI using AI with close to 100% sensitivity and specificity in PET images. The study is divided into two parts: the feature extraction using the LifeX software and the training of an ML algorithm using the dataset. The algorithm will extract different texture features from PET images of patients and identify infected grafts by the trained classification algorithm. The algorithm will be trained with anonymous PET scans to distinguish healthy and infected patients in MATLAB. The outcomes of the study will offer an AI-based, accurate, faster, and non-invasive method of detection. Ultimately, it seeks to offer a solution that operates in the clinic in which doctors can employ to aid them in the treatment plan for AGI.

Subjects: Engineering (STEM), Health and Medicine (STEM)

American Society After Bostock v. Clayton County: What Next?

Cassidy Tresidder

Faculty Advisor: Mark E. Schwartz, Ph.D.

In *Bostock v. Clayton County*[1], the Court answered the legal question of "does Title VII of the Civil Rights Act of 1964, which prohibits against employment discrimination 'because of . . . sex' encompass discrimination based on an individual's sexual orientation or gender identification?".[CJ1] In their decision issued in June of 2020, the United States Supreme Court decided an unprecedented case rooted in a controversial concept which permeated American society. Since the decision was rendered, the lower courts have used Bostock as precedent in order to draw parallels between the application of 'sex' in Title VII and the application of 'sex' in Title IX.

Comparing the two we see pertinent similarities which presumably has been the basis for the court's application of the Bostock precedent to Title IX cases. The interesting expansion of the new Title VII interpretation of 'sex' will be explored throughout the research and analysis contained herein.

Utilizing relevant cases from prior to the Bostock decision, and those that have come after (those that use the Bostock decision to interpret 'sex' in Title IX the newfound way that it was interpreted in Bostock under Title VII) will provide for an interesting analysis on how the law has changed in this area and where it could potentially go. Title IX and Title VII are inherently different laws, with different purposes, intended for different areas of the law, however the courts have managed to cross-apply the interpretation of a vague term ('sex') in one to the other. This paper will delve into the nuances of how the courts went about this cross-application and what their expansion behind the interpretation of the term 'sex' means for the future of our society regarding two pertinent issues: bathrooms, locker rooms, and things of that kind, and women's sports.

As Winston Churchill once said “[n]ow this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning.” In other words, after the Bostock decision a lot of people exclaimed with relief that the courts had finally answered the question definitively. However, a further understanding of the complications involved allows one ot see that with this decision, the end is not finalized. Everything we as a society know about sex discrimination may come into question because of the new policies including sexual orientation and gender identity in the definition of ‘sex.’

Subjects: Other

An Analysis of Non-Dichotomous Laws

Sarah Kelly

Faculty Advisor: Omar Rivera, Ph.D.

The existence of the Civil Rights Act of 1964 as a non-dichotomous law grants equal opportunity without requiring self-identification. Through the scope of a traditional feminist philosophical viewpoint, I will analyze what makes the Civil Rights Act non-dichotomous, and whether this framework can be applied to future laws, and how absence of dichotomies requires further statues to clarify its protections.

The US legal system relies on its ability to categorize cases presented to present verdicts in an orderly and timely manner. However, as individual identities become more multifaceted, our legal system fails to encompass all gender and racial identities for which protections exist. The acceptance of queer, nonbinary, trans, and intersex individuals has revealed issues with protections given to the traditional male/female dichotomy that stood as the foundation for civil protections since the founding of our legal system. The Civil Rights Act of 1964 allowed for equal opportunity for all people on the “basis of sex”. This laid the foundation for the continuation of the LGBTQ movement, and lead to equal protections for those who do not fall into the traditional male/female dichotomy.

The Civil Rights Act of 1964 was a non-dichotomous law – it gave protections to individuals without requiring them to self-identify. However, as time went on, other statues that extended on the Civil Rights Act of 1964 required identification. The Education Amendments of 1972 dictated that all schools must be equal in stature, allowed for the creation of single-sex schools if they were all equally funded. It did not dictate how trans and nonbinary students fit into this mold.

Subjects: Arts and Humanities

An Analysis on Imbalance Workload Pattern in the Cloud Cluster Trace

Zengxiaoran Kang

Faculty Advisor: Dilma Da Silva, Ph.D.

The drastic emergence of dynamic, heterogeneous, and shared cloud compute clusters has gained interest among corporates, researchers, and individual developers for the past decade. With the aim to improve further in the field of cloud data process and management, it is essential to understand the workload characteristics of large-scale cloud data centers. We analyze the publicly available trace released by Google Borg in 2019 and trace released by Microsoft Azure in 2019. The notable

workload characteristics of heterogeneity in resource types and usage in both traces suggest highly dynamic and varying jobs that demand faster and more scalable scheduling decisions.

In Borg trace, comparing the overall usage of the cluster to its capacity, we find that the average utilization of the cluster for each tier is overcommitted and demonstrates a frequent regulation of preemption to achieve its utilization. We propose an unsupervised learning K-means clustering to determine the centroid values of the clusters in schedulers and gain more insights into the characteristics of Borg's scheduling decisions. Additionally, in Azure trace, we address virtual machine (VM) workload performance and availability impacts with the same method. Since both data sets were tremendous, we manually sampled down to an appropriate size. Although the sample size prevents us from generalizing the trace behaviors, the analytical method we describe nonetheless extracts many system design insights into a scheduling decision-making process in a compute cluster.

Subjects: Engineering (STEM), Science (STEM), Technology (STEM)

An Analysis on the TGA Model for Stance Detection

Jeffrey Xu

Faculty Advisor: Ruihong Huang, Ph.D.

Stance detection, a problem concerned with finding the stance that an author takes on a specific issue, is a large subset of NLP and A.I and its uses can already be seen in a multitude of applications. The majority of stance detection machine learning models are tested against a popular dataset called SemEval2016, which is a collection of tweets, authors, topics and stances. Many researchers across the globe have created machine learning models to accurately predict the stance of authors based on their tweets regarding a certain topic. However, researchers at Columbia university have created a new dataset called VAST along with a model called TopicGrouped Attention (TGA) that claims to perform well on zero-shot stance detection, which is a subset of stance detection that focuses on determining the stance of authors on new, never seen topics. Their VAST dataset focuses on this zero-shot subproblem by including a variety of topics. In this thesis paper, we analyze how the TGA model performs on the SemEval2016 dataset and determine whether the TGA model improves on the current existing zero-shot stance detection models.

Subjects: Engineering (STEM)

An Exploration of Educational Algorithm Visualizations Using Web Technologies

Nkemdi Anyiam

Faculty Advisor: Dilma Da Silva, Ph.D.

Certain algorithms (such as those for dynamic programming (DP)) lack visualizations that can exhaustively explain each step while delivering intuitive animations, in part due to rigid layouts in the designs. In this paper, we show that these problems can be solved using modern web technologies—namely HTML5/CSS3 and Javascript—by demonstrating an animation framework that lets developers create a timeline of animations that easily integrates into the flow of front-end web development. We also put forth and discuss design rationale and recommendations for algorithm visualizations in general.

The framework supports typical playback features like rewinding, changing playback speed, skipping, etc., and it allows the developer to specify various parameters that let them fine-tune the animation sequences. Outside of that, we are free to incorporate any UI/UX designs that would aid students' overall comprehension, allowing a closer relationship between text explanations and graphics as well as connections between elements that would normally be isolated in panels.

To test the framework, we created a visualization of a DP algorithm for memoized weighted interval scheduling (WIS). WIS is tedious to solve by hand, so instructors typically skip iterations and expect students to have internalized the in-between steps. Our test, however, takes user input and procedurally generates the visualization, including text explanations at every single step of the way. Repetition can be crucial to understanding concepts in full, so by showing all of the parts that a professor would never have time to write down and providing an interface that supports useful playback controls, we have created a way to visualize algorithms that boosts intuitive design and supports different learning paces.

Subjects: Education, Technology (STEM)

An Implementation of the Parallel K-Core Decomposition Algorithm in GraphBLAS

Pranav Konduri

Faculty Advisor: Timothy A. Davis, Ph.D.

The k-core of an undirected graph is the largest subgraph in which every vertex has a degree of at least some number k. Computing the k-core, also known as the k-core decomposition algorithm, has significant applications in network analysis, visualization, bioinformatics, and community detection. There exists a sequential procedure, developed by Batagelj and Zaversnik in 2003 that accurately performs k-core decomposition. This implementation has been consistently referenced as the gold standard, due to its O(n+m) runtime. However, due to its non-parallel nature, its performance suffers on modern big-data graph problems where sheer size tends to overwhelm runtime due to latency. A 2014 algorithm designed by Dasari, Desh and Zubair M implements a parallel version of k-core decomposition with significant speedup, and a 2017 algorithm designed by Kabir and Madduri provide even further improvements. We will implement the parallel k-core decomposition algorithm using the GraphBLAS API in C, a parallel, extendable framework that defines a set of matrix and vector operations based on an algebra of semirings to perform computations on graphs. The implemented algorithm will be tested rigorously for accuracy on both small and large graph problems in order to analyze efficacy, as well as benchmarked versus the 3 other implementations of the algorithm.

Subjects: Engineering (STEM), Mathematics (STEM), Science (STEM)

An In-Switch Architecture for Low-Latency Microservices

Jackson Petroll

Faculty Advisor: Riccardo Bettati, Ph.D.

In recent time, there is has been a movement away from the standard monolithic architecture towards what is known as a microservice architecture. Microservice architecture decomposes the previous monolithic architecture into multiple independent services called "microservices". Examples of applications that use this microservice architecture include REST API and JSON. These applications will send large numbers of microservice requests, which go through the OSI network

layers to establish a client server connection. REST API, for example, is used in the HTTP environment and uses multiple GET, POST, PUT, DELETE, and other request that are sent to the API gateway that which are then forwarded to the other services. This trend towards microservices has developed interest by other researchers to make improvements in this field, due to the growing reliance importance on such architectures by consumers. There have been studies regarding the security of these microservices, performance analysis of various applications, and the use of these microservice applications in cloud technology. Any improvements in the speed, security, or organization of such network architecture Would be very beneficial in regards speed of these popular API's, and their user base. This project's desire is to observe the potential of moving some of the processing that is done for these micro-services within a network switch. This would ideally improve the performance at the application level, by alleviating network communication overhead by preforming micro-service processing within the switch.

Subjects: Engineering (STEM), Science (STEM), Technology (STEM)

Analysis of Calling Context Encoding Algorithms

Victoria Rivera Casanova

Faculty Advisor: Eun J. Kim, Ph.D.

My research area falls under Hardware Security and deals with Calling Context Encoding and Decoding. Calling contexts of programs provide important information to developers that help with event logging, event reduction and bug reporting. The motivation for this research is being able to distinguish between a program's current calling context and another calling context at runtime. There are prior works being looked at, such as Precise Calling Context Encoding (PCCE), where an integer ID is assigned to a program's calling context at runtime. Using this ID and the last visited function of the program, the context can be decoded. However PCCE has limitations to its encoding scheme that make some calling contexts impossible to distinguish. Distinguished Calling Context Encoding (DCCE) is a novel encoding scheme that addresses the limitation of DCCE and aims to be a more efficient encoding algorithm. I implemented DCCE as a dynamic instrumentation algorithm using Intel's Pin Tool Framework This version of DCCE allows for the target program's binary file to be updated during execution as opposed to before the program is running. The goal of my research is to find the answer of whether we can improve upon the current encoding algorithms (PCCE and CCTLib) in terms of runtime efficiency with DCCE.

Subjects: Engineering (STEM), Technology (STEM)

Analysis of High Proper Motion Faint Dwarfs in Gaia EDR3 x DES Y6

Will Chisholm

Faculty Advisor: Louis Strigari, Ph.D.

We analyze a sample of ~1,200 high proper motion faint dwarfs using astrometry from Gaia EDR3 and photometry from DES Y6. Various color processing and correction algorithms are applied to this dataset to obtain an extremely clean and reliable five-parameter solution sample. This sample contains a diverse set of mainly K- and M-type dwarfs originating from a variety of sources. We particularly focus on a subsample of main-sequence sources of varying effective temperatures and spectral types, allowing for further probing of the local spiral structure.

Subjects: Science (STEM)

Analysis of Protozoal Population Differences in Cattle Sub-Species

Alyson Fontenot and Charlotte Heide

Faculty Advisor: Tryon Wickersham, Ph.D.

Previous research suggests that *Bos taurus taurus* cattle (BT) are less feed efficient, have dissimilar levels of methane production, and exhibit lower levels of nitrogen recycling than *Bos taurus indicus* cattle (BI), but the basis of these variations are not well characterized with regards to protozoal digestion of feeds. The differences in protozoal populations within the foregut of the subspecies of cattle is relatively unknown; therefore, the natural progression for starting research in this area is collecting data to understand the extent of said differences. Dissimilarities in feed efficiency among other digestive functions in BT and BI may be closely associated with resident foregut protist populations, making this area of research valuable for future precision feeding techniques as well as aiding in the reduction of methane production. Within this study, samples of rumen contents from 6 BT and 6 BI are analyzed over a period of time concurrent with varying levels of nitrogen and carbohydrate supplementation. Data for comparisons will be presented in the form of protist concentration as well as visual identification and enumeration of key species, analyzing both individual data and data compiled for both cattle subspecies. Expected differences in protozoal populations include a suggested increase in protozoal concentration within BI rumens compared to BT rumens, with an emphasis on larger numbers of *Entodiniomorphids,* the species commonly associated with microbial protein turnover, as well as *Polyplastron*, *Epidinium*, and *Eudiplodinium* which have high cellulolytic activity that may contribute to BI's increased feed efficiency.

Subjects: Science (STEM)

Analyzing Cricket Songs with Machine Learning

Christian Smith, Lance Ondrej, and Richard Liu

Faculty Advisors: Yoonsuck Choe, Ph.D. and Hojun Song, Ph.D.

Crickets produce songs by a process called stridulation, "the rubbing together of their forewings, whereby the plectrum of one wing is rapidly passed over a serrated file on the opposite wing" (Jonsson et al. 1). Research has shown that the carrier frequency (the frequency that makes up the largest portion of a sound) produced by a cricket is highly correlated with the "stridulatory apparatus" (Montealegre et al. 11).

Given the recordings of cricket songs, our goal was to create a model that could match the correct species to any given song. First, we needed to take out noise in the data using a high pass filter and delete other .mp3 files that had too much noise. We had a few different options for how we wanted to represent the cricket songs in data form: Magnitude power spectrums, mel spectrograms, and mel frequency cepstrum coefficients. We ended up utilizing the song data we had to create multiple mel spectrograms for each cricket species since, in the end, this proved to give us the highest accuracy of the three options. 80% of the mel spectrograms were then fed into our model for training while the remaining 20% was used for testing the accuracy of the model.

A major challenge we encountered was how we would best distinguish between differing cricket species that belonged to the same genus since this was causing us to achieve very low accuracy initially. We decided to simplify our sample size from the 133 cricket species under 26 genera to the

5 genera with the highest number of species that we had song data for. Then instead of predicting the species, we would seek to simply classify the genus that the song data was coming from. This allowed us to dramatically improve our model's accuracy to be consistently over 90%. With enough data available, we believe that we could classify a more diverse sample set of cricket species with a similarly high level of accuracy.

Subjects: Engineering (STEM), Mathematics (STEM), Technology (STEM)

Analyzing Deep Learning Algorithms for Recommender Systems

Tianyu Gu

Faculty Advisor: James Caverlee, Ph.D.

As the volume of online information increases, recommender systems have been an effective strategy to overcome information overload by giving selective recommendations based on certain criteria. The most traditional way of developing a recommender system is using matrix factorization, which works by decomposing a user-item interaction matrix into the product of two lower dimensionality rectangular matrix.

In recent years, deep learning has garnered considerable interest in many research fields such as computer vision and natural language processing. These successes are made possible by deep learning algorithms' outstanding ability to learn feature representations non-linearly. The influence of deep learning is also prevalent in recommender systems, as demonstrated by its effectiveness when applied to information retrieval and recommender research. This research project performs a detailed analysis on two deep learning algorithms, autoencoder and convolutional neural network, and how they perform in recommender systems compared to matrix factorization.

Subjects: Engineering (STEM), Technology (STEM)

Analyzing External Memory Politeness Control for Web Crawling Applications

Vidith Madhu

Faculty Advisor: Dmitri Loguinov, Ph.D.

One of the key components of many problems in computer science is organizing and querying large volumes of data in an efficient manner. Specifically, such problems arise in the domain of web crawling. In this work, we are concerned with the task of efficiently observing a per-host politeness policy in web crawling, which is an anti-spam mechanism using request limits published by individual hosts. Typical methods to observe such constraints require a priority queue structure that maintains information about when a host was last visited and the next available host to be crawled. However, once a crawl scales to hundreds of millions of unique hosts, maintaining such a structure in-memory can become infeasible on many workstations and other limited resource settings. Past work conducted in our lab has shown dramatic performance losses in the web crawler BuBING due to excessive RAM consumption, partly due to its politeness control scheme. In this work, we investigate methods of offloading politeness control to external memory. We first describe the history and specific applications, challenges, and considerations of developing external memory algorithms. We then present two external memory solutions that can be used for politeness control: A priority queue implementation from STXXL, a popular C++ library of external memory algorithms/data structures, and a customized solution, which we name a *rolling priority queue*, which exploits specific properties of the politeness control problem for a simpler approach. We then discuss specific

methods for applying these solutions for politeness control, their theoretical performance and measured benchmarks, and limitations/open questions that motivate future work in this area.

Subjects: Engineering (STEM), Science (STEM)

Analyzing Recommendations on Social Networks to Discover Bias

Diva Kohli

Faculty Advisor: James Caverlee, Ph.D.

Recommender systems have become increasingly prevalent online within the last two decades and are used extensively on social media and networking platforms. We look at one such platform, LinkedIn, which serves the purpose of matching job candidates to open jobs and connecting recruiters to job seekers. However, an issue that arises from the use of recommender systems for this purpose is that certain candidates' profiles may be more visible to recruiters based on keywords in their profiles. Similarly, certain jobs may be shown more often to candidates based on their descriptions, possibly resulting in bias when it comes to networking and potential hiring chances. Because of the impact this could have on both companies and candidates, it is important to ensure that recommendations resulting from these systems are not biased or unfair.

To address these issues, we look into the approaches used to design recommendation systems, and more specifically, analyze how LinkedIn's search and recommendation algorithms work. We run experiments to see the recommendations of the system for various search queries and analyze our results in order to determine whether or not bias is observed. Based on our observations and the factors that seem to have a greater influence on the recommendations made by the algorithm, we will then propose ways to potentially reduce any such bias in hopes of increasing fairness and showing people more relevant opportunities.

Subjects: Technology (STEM)

Analyzing the Impact of the Rapid Transition to Virtual Work on Students and Professionals

Elinor Krits

Faculty Advisors: Tracy Hammond, Ph.D. and Paul Taele, Ph.D.

The coronavirus pandemic that first began sweeping the globe in 2020, and more commonly referred to as COVID-19 caused the world to shut down on nonexistent notice. Every organization that could, rapidly switched over to a virtual environment, but this transition was far from seamless. Individuals who had never interacted with technology for purposes other than recreation, such as reading the news, watching shows or playing video games, were forced to learn how to use it to complete the tasks required of them for work or school. In this work, I discuss the findings of a study that was conducted for the purpose of collecting information about people's experiences in different work environments (in-person, virtual and hybrid) in order to learn more about whether age, profession, distance to work and several other factors make a difference in how people were affected by the transition to virtual caused by the coronavirus pandemic. By analyzing the survey results of 104 individuals and the interviews of 12 of them using both qualitative and quantitative approaches, some of the key issues that people were facing are identified. Despite there being a variety of issues that were brought up, there were several common themes that were present and

were often the ones that appeared to irritate users the most. Through the thorough comparison of individuals' experiences in in-person, online, and hybrid spaces, it can be seen that issues that were previously faced by people when attending work, school, events, etc. in-person were reduced or eliminated by the shift to virtual; however, some new issues surfaced and old ones were aggravated. I propose what seems to be the best approach moving forward that would allow for all parties involved to see the greatest benefits.

Subjects: Engineering (STEM)

Applying Activity Recognition to Enhance Macro-Nutrient Predictions Using Wearable Devices

Tony Yang

Faculty Advisor: Bobak J. Mortazavi, Ph.D.

Exercise detection is key for those who want to accurately detect exercise and provide recommendations for a healthy lifestyle. We also want to look into correlations between glucose levels and exercise moments and see how glucose levels vary with exercise. However, this can be challenging given various contexts imbalanced data and other contexts. Therefore, we attempt to build a model by using a decision tree model called Extreme Gradient Boost (XGBoost) and compare how our model performs with just E4 Watch data vs the E4 Watch Data plus glucose monitor. A sliding window is used to extract statistical measures such as standard deviation, mean, and range to look for patterns correlated to exercise. During our model building, we use a technique called Syntheic Minority Oversampling Technique, or better known as SMOTE, to help generate similar data to mimic our underrepresented label of exercise moments. This is so the model can better be better trained. We finally conclude that it is not entirely possible to detect exercise with current methods but that the model is not to be strictly relied on since this does necessarily apply to all humans. Further, we also find that it is difficult to detect correlations between glucose levels and exercise moments.

Subjects: Health and Medicine (STEM), Science (STEM), Technology (STEM)

Athlete Perception of Competing on Artificial Turf Versus Natural Grass in Extreme Heat Conditions

Saman Siddiqui, Jacqueline Cardenas, Brian Hinojos, and Marisa Cuevas

Faculty Advisors: Chase Straw, Ph.D. and Steven Riechman, Ph.D.

Third-generation (3G) artificial turf sports fields have been utilized since the 1990s. Research has shown the surface temperature of these turf fields can reach up to 170°F. This temperature is significantly higher than natural grass fields and raises concerns for athletes. No known literature currently has examined the hydration status and performance of athletes on turf versus grass fields. There was a lack of research done regarding an athlete's hydration status on turf and grass. We made comparisons of turf and grass, focused on injuries, different surface temperatures, and possibly investigate further research regarding hydration on only artificial turf.

The purpose of the study was to evaluate the athletes' perception of hydration status and performance on grass versus turf and how they prepare for each.

We hypothesize that the participants will say they've become dehydrated more quickly playing on turf in comparison to natural grass. Additionally, we hypothesize sharing the results of the hydration study will alter the athletes' perspective on dehydration when competing on grass versus turf fields. Athletes ranging from 18-28 years old were given two surveys using RedCap on their hydration preparation and game behavior. The participants were divided into two groups. The first group was the hydration group, where we took measurements of their weight loss, sweat production, urine samples, heart rate, active participation, distance traveled, and body temperature. In the other group we measured heart rate, active participation, and distance traveled. One survey was given before receiving results and information. Participants had either previously completed a two-day hydration study playing on both turf and grass 6 months before this survey was completed. We surveyed all the athletes that were part of a men's soccer club team, however, we primarily looked at the ones that participated.

Subjects: Science (STEM)

Benchmarking Ethereum Smart Contract Static Analysis Tools

Terrell Ford

Faculty Advisor: Jeff Huang, Ph.D.

This project benchmarks the operation of existing Ethereum smart contract static analysis tools. This is to support the proliferation of tools which allow developers to screen their Ethereum smart contracts for security vulnerabilities and determine what tool or tool suite would be most appropriate for bulk scanning of the entire Ethereum decentralized finance (DeFi) space. This is achieved by comparing the relative performance of several separate static analysis tools on various curated smart contracts. Each tool is made to analyze a list of smart contracts which have known vulnerabilities of various categories dispersed throughout. The resulting output of each static analysis tool is analyzed in several key ways. First, the general runtime of the tool is measured for each input smart contract. This is broken down into metrics such as time taken per line of code, time per kilobyte of file size, and time vs code complexity. Second, the number of vulnerabilities detected by each tool is taken into account. Each tool is capable of detecting different types of vulnerabilities with substantial overlap between tools. The capabilities of the tools are evaluated and scored based on the number of total vulnerabilities found, as well as how many different types of vulnerabilities are capable of being found. Finally, the general accuracy of each tool is compared. The number of false positives and false negatives for each vulnerability category and tool are displayed and compared. Added together, these three benchmarking categories are combined into an overall usability score for each tool. This usability score is employed to determine what tool or set of tools could be used to screen individual smart contracts, as well as bulk-scan the entire DeFi space.

Subjects: Engineering (STEM), Technology (STEM)

Benchmarking the Performance of Machine Learning Algorithms for Record Linkage at Different Heterogeneity Rates in a New Setting

Hariharan Sivakumar

Faculty Advisor: Hye-Chung Kum, Ph.D.

Record linkage is used to identify and link the same entity from one or more databases when a unique identifier is absent. As the amount of data increases largely every day, machine learning has

become effective in integrating data with heterogeneity from multiple sources to establish more comprehensive datasets. As it is challenging to build a high-quality labeled dataset to train good models, our aim for this research will be to investigate which machine learning models will work best under certain conditions when applying these models trained in one setting to a new setting. In this paper, we compare the performance of three different machine learning models (i.e., random forests, linear SVM, and radial SVM) trained in a different setting from an open source hybrid record linkage system using different heterogeneity rates (0% - 60%). The RL heterogeneity generator introduces name errors, date errors, missing data errors, and record level heterogeneities in the data. The models were trained on a subset of hospital record data containing nearly 10,000 pairs. We test how robust these models are in a new voter registration dataset. The performance of the models was evaluated based on F1 score, Recall, and the percentage of pairs that needed manual review. The radial and linear SVM models transfer better to a new setting across all heterogeneity rates compared to the random forest model. The linear SVM model outperformed the radial SVM by 4% on average in terms of the percentage of pairs that needed manual review. However, we found that the radial SVM performed significantly better than the linear SVM in terms of recall performance (80% - 48% compared to 59% - 29%) for heterogeneity rates from 0% to 60%. Overall, the radial SVM performed best in our experiments.

Subjects: Engineering (STEM)

Calcareous Nannofossils and their Relationship to Climate Variability

Haley Mossell

Faculty Advisors: Denise Kulhanek, Ph.D. and Leah LeVay, Ph.D.

Calcareous nannofossils record surface water conditions and therefore hold insights to how the climate has changed as time has passed on Earth. This study uses this characteristic of nannofossils to understand how the glacial and interglacial cycles have impacted the Mozambique Channel over the Pleistocene. To do this, nannofossil assemblages were analyzed from two piston cores, MD13-3504 and MD13-3506 that were obtained on research cruise MD13 to the Mozambique Channel. These nannofossil assemblages were analyzed under a microscope and species abundances were counted and recorded. Tracking the number of species is pivotal to this study because calcareous nannoplankton are able to record changes in surface temperature of the ocean and nutricline depth. For instance, important species such as *Gephyrocapsa oceanica* is strongly linked to warm ocean waters, whereas cooler waters are favorable for *Gephyrocapsa muellerae*. Additionally, as a well known lower photic zone dweller, *Florisphaera profunda* is able to act as a proxy to understanding the depth of the nutricline. When there is abundant *F. profunda,* the nutricline is deep and conversely, when the nutricline is shallow due to upwelling, *F. profunda* is minimal. The samples for this study are dated to the middle to late Pleistocene, making species extinctions and evolutions such as the extinction of *Pseudoemiliania lacunosa* and the evolution of *Emiliania huxleyi* crucial to creating an age model for the studied cores. By examining the nannofossil specimens recovered from the two piston cores, a more thorough sediment record will be developed for this region during the middle to late Pleistocene contributing to the understanding of how climate change affects ecosystems.

Subjects: Science (STEM)

Campesina Empowerment: Understanding Gender and Development in Rural Guatemala

Jose Solis

Faculty Advisors: Dinah Hannaford, Ph.D. and Leslie Ruyle, Ph.D.

A lack of understanding of an indigenous community can hinder the progress of a development project, regardless of its intended mission. For rural Guatemalan women, both international and domestic development projects fail to account for their day-to-day lifestyles. Throughout Guatemala, development projects have increasingly shifted their focal point towards rural women, while maintaining verbiage from previous non-female specific projects. Although Guatemalan development projects target Guatemalan women, they fail to contextualize the specific conditions required to empower women within Guatemala. Understanding the context by which rural women exist, reveals the in-depth knowledge of a population needed to implement a project. If development projects don't contextualize their verbiage and definition of empowerment, what disparities will arise from this lack of context for women empowerment? Previous research has concluded that key components of empowerment (e.g., economic capacity, human capital, social capital, gender equality, political influence, self-esteem, and awareness) are necessary to empower Guatemalan women (Lundström & Morén, 2017, abstract). However, Guatemalan Development projects fail to contextualize these within the context of project's policy verbiage. Therefore, as a part of this study, I analyzed a combination of policy documentation and current development projects, concerning rural Guatemalan women, incorporating a modified version of Lundström and Morén (2017) model on women empowerment through a political, economic, and social lens. By focusing on case studies of international and domestic Guatemalan development projects, I came to understand how development projects in Guatemala perceive empowerment and how rural Guatemalan women are empowered or disempowered by these projects. By examining how rural Guatemalan women are incorporated based on their development project's perceptions, this paper seeks to contribute to the understanding of how development projects should approach indigenous women communities, specifically in rural Guatemala.

Subjects: Arts and Humanities

CaveCrawler: An Interactive Analysis Suite for Cavefish Bioinformatics

Annabel Perry

Faculty Advisors: Heath Blackmon, Ph.D. and Alex Keene, Ph.D.

In recent years, non-traditional model organisms have become increasingly important for health and evolutionary research. These model organisms are necessary for some forms of research, as some diseases and evolutionary mechanisms can be studied only in specific species. The Mexican tetra is one such non-traditional model organism. This species consists of two morphs, a surface-dwelling and a cave-dwelling morph, which differ in key phenotypic features such as sleep, metabolism, and anxiety. Due to the homology between human and Mexican tetra genomes, these morphs are naturally occurring control and experimental groups with which to study the genetic basis of human disorders of sleep, metabolism, anxiety, and much more. Though Mexican tetra genetics research has proliferated in recent years, this surplus of data presents a challenge for researchers. There currently exists no central location in which to access Mexican tetra genetics data and no easy way to compare data from across studies and experimental contexts. To address this need, we created CaveCrawler, a web-based genetics inference tool which combines Mexican tetra genetics data from many studies to enable cross-study comparisons and identification of yet-to-be-answered research questions. In addition to advancing research in the Mexican tetra, CaveCrawler's open-source code can be adapted to incorporate data from other species, enabling researchers to create web-based genetics inference tools for their own non-traditional model organisms.

Subjects: Science (STEM)

Cinders Fall: A Creative Artifact and Study in Female Protagonists in Fantasy Web Based Graphic Novels

Amelia McCarthy

Faculty Advisor: Samuel Woodfin, MFA

Fantasy genre-based media is a long and varied canon and continuum. Female protagonists of this genre have long been pandering and pedantic, and only recently have female protagonists been given the empowering and engaging characterization that their male counterparts have enjoyed for decades. With the advent of web based graphic novels, ease of access to publishing and reading graphic novels in particular has increased greatly. With this, there are more female-written and female-featuring graphic novels than ever. And yet, there can still be something said for the fantasy genre of web based graphic novels. Female protagonists of this genre in this medium are often fawned over by a cast of males, or lack any real agency, or authenticity. With these thoughts in mind, Cinders Fall is the culmination of my research on female protagonists of the fantasy genre as a larger canon, female protagonists of fantasy web based graphic novels, web based graphic novels as a medium, and the fantasy genre as a larger canon of media. Cinders Fall is my web based graphic novel featuring my female protagonist Nox as she travels the world on a dangerous quest, finding out more about her lineage and herself along the way. My worldbuilding, characterization, and production of my creative artifact were all affected by my research, and I am proud to display it all here. I go into detail on my process, my research, the struggles I encountered, and all the words I have poured into making this creative artifact. This thesis is the synthesis of my research and my passion, and Cinders Fall is a love letter to the fantasy genre and web based graphic novels.

Subjects: Arts and Humanities, Creative Works

Climate Change and Natural Disaster Loss Prediction in the United States

Jordan Vick

Faculty Advisor: Michelle Meyer, Ph.D.

This project intends to answer the question of how rising disaster losses correlate to essential climate change variables. Despite the well-established upward trend in economic losses from disaster, there is still debate over whether anthropogenic climate change has been the main driver of losses, due to the need to control for complex socioeconomic variables such as population, social vulnerability, economic growth effects, and more. The project will investigate the effects of temperature, precipitation, and vulnerability on disaster losses to examine how these measures have predicted the human cost of disaster. I hypothesize that climate indicators will predict disaster damages, and that these effects will be modified by social vulnerability and exposure. I also predict regional climate data will predict damages more accurately than global data. By illuminating the variables that best predict losses and identifying quantitative trends, this project will quantify the relative contribution from anthropogenic climate change to disaster losses and provide helpful information about the predictive power of individual climate variables. Quantitative analysis of the secondary data will be conducted and the implications of climate change in the future will be discussed, as well as a review of the literature, especially in the area of disaster attribution. The secondary data are available through NOAA, SHELDUS and NLDAS datasets. These data will be used

to quantitatively study the relationship of specific climate variables to disaster losses with social vulnerability as a control variable. Correlation analysis will be conducted on a county-level and global scale using Stata.

Subjects: Social and Behavioral Sciences

Coercion After War: Becoming a Frozen Conflict

Essynce Lewis

Faculty Advisor: Carmela Garritano, Ph.D.

The discourse surrounding coercive diplomacy often analyzes the behavior of aggressor states prior to the outbreak of war or the use of force. In doing so, scholars examine the intentions of the aggressor state to change the status quo. However, it will be insightful to trace the behavior of both the coercer and the target state after the war concluded and while tensions remain unresolved. Post-war tensions imply an unstable peace since the target never conceded to the demands of the coercer state. In such instances, these conflicts become frozen and place the status quo in an indeterminate state, essentially requiring a reset to the process of coercive diplomacy. By tracing the developments post-war, we can identify the factors that hinder the conflict resolution process even after the coercer carries out their threat. This paper aims to discover how de-facto states depend on international coalitions to survive and inadvertently shape the conditions for a frozen conflict. This paper will specifically consider the role of informal empires and the legacy of colonial-drawn borders.

In a post-colonial world, an informal empire is often a reconstructed albeit cloaked version of itself as a former colonizer. This means that it is accustomed to, or perhaps even expects, the continued subordination of former colonies. I will use the war in the Donbass and the annexation of Crimea as a case study to demonstrate the colonial impact of the Soviet Empire.

Subjects: Arts and Humanities

Cognitive Changes and Circadian Timekeeping Disturbances in Aging

Andrew Powell

Faculty Advisors: Karienn Montgomery, Ph.D. and Gregg Allen, Ph.D.

Cognitive changes in aging and Alzheimer's disease (AD) are often accompanied by pronounced disturbances of circadian timekeeping, especially the sleep-wake cycle. Normal circadian timekeeping has an important impact on human health and performance by providing the temporal coordination of internal processes to ensure their occurrence at the "right time" relative to each other and to the external environment. The aging of the rodent circadian system is characterized by changes comparable to those in human aging and AD. Common disturbances in the sleep-wake rhythms of aged rodents include alterations in circadian activity. However, not all aged rodents show these changes, demonstrating the variability characteristic of human aging in pre-dementia or mild cognitive impairment (MCI). Because the aging population also shows variability in onset and magnitude of cognitive impairment, we explored the relationship between these cognitive deficits and sleep disturbances during aging in mice.

The circadian rhythm of locomotor activity was continuously analyzed for 30-40 days in young (3-5 mo), middle-aged (12-14 mo), and aged (18-24 mo) mice. We then tested the mice in the Barnes maze for learning and memory performance. Aged mice exhibited significant impairment of cognitive behavior in conjunction with striking changes in their circadian patterns of activity. Interestingly, we observed a gender-specific relationship between cognitive impairment in the Barnes maze and increased variability in daily onset times of circadian activity in aged female mice (20-24 mo).

We are currently testing middle-aged animals (12-14 mo), to determine if behavioral deficits occur earlier in the lifespan and whether changes in circadian activity occur prior to cognitive impairment. This data will be the foundation of our model to further understand the relationship between circadian synchronization and cognitive impairment, and to probe possible mechanisms of action.

Subjects: Health and Medicine (STEM)

Collaborative Robotic Motion Planning

Thomas Cousins

Faculty Advisor: Shawna Thomas, Ph.D.

When attempting to plan for a robots movement between two points there are many factors to consider, including the number of joints the robot has, causes for collision, power usage, fastest path, and others. These factors compound themselves as both the robots involved increase in joints, there is an increase in obstacles, or more robots are added to the system. In an effort to solve this problem, previous work has been done on Reachable Volumes and Interaction Templates, algorithms that serve to reduce the processing time for high degrees-of-freedom (dof) robots with high constraints, and to reduce the processing time for certain tasks, respectively. Reachable Volumes uses the volumes that each unit of the robot can occupy to solve for a configuration at a given point. This enables a quick way to evaluate a configuration for a high dof robot as well as providing an easy means of avoiding collisions with obstacles. Interaction Templates can be used to "template" or formulate an interaction such as a handoff that can be applied to a "roadmap" or a collection of points that make up the movements of a manipulator in configuration space. In doing so, Interaction Templates can make complex and processing expensive tasks such as calculating a handoff much more efficient and quick. The work below integrates elements from the Reachable Volumes algorithm into Interaction Templates, effectively speeding up several steps on the Interaction Templates Algorithm as well as making it more effective for high dof robots, as conventional motion planning algorithms have trouble positioning the end effector close enough for some interactions to occur.

Subjects: Engineering (STEM), Technology (STEM)

Comparative and Mathematical analysis of the swimming patterns of Paramecium tetraurelia with Cortical inversions.

Benjamin Offereins

Faculty Advisor: Karl Aufderheide, Ph.D.

Paramecium tetraurelia are single celled protists commonly found in freshwater. Paramecia are covered by 3,000 cilia, organized into about 70 longitudinal rows. Rows can be inverted 180 degrees

through a technique using heteropolar doublets. Paramecia swim in tight, left-handed helical patterns, and inversions appear to cause a wider helix. Previous studies done on the inverted swimming pattern of paramecia focused on *P. tetraurelia* Invert E. These studies produced an equation linking the inverted rows to the twistiness of the swimming pattern. I examined whether inversions of different sizes and locations would confirm the trends established by the equation by studying three new inverts. Invert 1 is still being studied. Invert 3's inversion starts at row 41 and lasts 5 rows, which is significantly different from Invert E's that starts at row 26 and lasts between 5-19 rows. Invert 2's inversion starts at row 60 and lasts 5 rows that are split by 1 normal row. Analysis of the swimming patterns appeared to show some evidence of variation between the swimming patterns of Invert 3 and Invert E. Nevertheless, the general trend predicted by the equation held true: the greater the number of inverted rows the more twisty the swimming pattern. However, my research also indicated that swimming patterns are significantly affected by variables that are difficult to control, such as nutrition, the paramecium's stage in the reproductive cycle, and the paramecium's size, which increased the variability in my data.

Subjects: Science (STEM)

Compatibilism's Problem with Luck

Daniel Lightsey

Faculty Advisor: Roger Sansom, Ph.D.

Typically it is thought that libertarians, those who think that free will, defined as the control condition on moral responsibility, is incompatible with determinism but affirm the existence of free will, suffer from the problem of luck. Due to this problem many philosophers, particularly compatibilists, believe that traditional libertarianism does not in fact grant us the significant freedom required for moral responsibility. The type of indeterminism involved these theories of free will just does not do the job to grant us control over our action; rather, it seems that this indeterminism is something that we would have no control over--it would simply happen to us. While this is a problem for the libertarian, this objection is typically used by compatibilists to argue that libertarianism fails while their theory of free will succeeds because it does not suffer this problem of luck. However, in this paper I contend that compatibilism faces a very similar problem of luck. Once we understand the problem of luck correctly, i.e. once we fully understand exactly what the problem is that is causing the libertarian agent to lose control, it becomes clear that compatibilists suffer from the problem of luck just as much as the libertarian. Thus, compatibilists avail themselves of the problem of luck at their own peril. If the problem succeeds in rendering libertarianism unsatisfactory, this will be equally true of compatibilism.

Subjects: Arts and Humanities

Computing Realistic Images Ray Tracing Teaching Tool

Michael Stewart

Faculty Advisor: Shinjiro Sueda, Ph.D.

My research is associated with the field of education in the Computer Graphics domain and specifically associated with the education of ray tracing concepts. Ray tracing is a complex topic lacking good educational and interactive tools for both classroom demonstration and student independent study. The industry acceptance and resulting photorealism makes ray tracing an

important concept that Computer Graphics students need to learn. Ray tracing concepts are taught in introductory and advanced computer graphics classes around the world.

The concepts associated with ray tracing are challenging to teach through slides because there are no intermediate visual output steps to aid student's understanding of the concepts. A tool that makes visible the underlying steps to produce a specific image would benefit both teachers and students. Interactive engagement with the tool allows students to more easily grasp the step-by-step process and would encourage student exploration and curiosity. Computer Science teachers would typically not want the source code for an assigned project the student is to build to be exposed; to reduce temptations for copying the code. Advancements in hardware technologies have enabled real-time ray tracing to be used in graphics rendering engines and game productions. The need for an interactive instructional tool that allows for camera controls, contains presentational aids and is easily accessible to teachers and students is high. My research project is supervised by Dr. Sueda, a TAMU Graphics Professor. The goal of the project is to build a tool that will aid in teaching ray tracing concepts to students.

Subjects: Creative Works, Education, Engineering (STEM), Technology (STEM)

Contributing Factors, Current Treatments, and Gaps in Research of Intrauterine Device Insertion Pain

Katie Stephenson

Faculty Advisor: Charles W. Peak, Ph.D.

Intrauterine devices (IUDs) are a form of contraception that boasts high efficacy, affordability, and ease of use; however, these devices are considered underutilized in the United States, where rates of unplanned teenage pregnancies are higher than those of similarly industrialized countries. High pain levels experienced by some patients during IUD insertions may deter individuals from pursuing this form of birth control. While IUD efficacy and general safety have been a topic of scientific discourse for decades, patient experience and discomfort remain overlooked. Research has widely concluded that pre-procedure anxiety and nulliparity heighten insertion pain, yet existing studies on treatments are scarce, irrelevant to modern devices, fail to demonstrate significant reductions in pain, or use a subject sample that is not representative of the population using IUDs today. Off-label usage and regulatory exemptions have allowed this discomfort and pain to go unaddressed. Consequently, the field currently lacks an established standard of care, leading to inequitable and ineffective practices. Additionally, through vague device labeling, widespread stigma, and limited contraception education, physicians and patients alike are often misinformed about IUD insertion pain and treatments. In a healthcare system that supports advanced methods of managing pain in other specialties, the intolerable pain some females experience in this simple procedure should not be as prevalent and misunderstood as it currently is. Evaluating, establishing, and promoting an adequate standard of care could make IUDs more accessible and reduce the occurrence of adverse patient experiences, thus increasing usage, addressing ethical concerns, and lowering rates of unplanned pregnancies.

Subjects: Engineering (STEM)

Controversial Saints: A Study in How Popular Culture Can Radicalize Religious Icons

Alexandria Babineaux

Faculty Advisor: Sam Woodfin, MFA

The Catholic pantheon of Saints is a vast and expansive collection of unique characters. Their escapades are outlined primarily in the Bible, but also spread across texts such as the Torah and Quran and even secular spaces. Being raised in the Christian church I was always fascinated by these figures and their depictions in religious stories. As I grew older my relationship and perception of religion changed, but my fascination with individuals and their art remained. In recent years I have discovered that many of these beloved saints have come to have radical transformations in their interpretations and use, primarily influenced by modern culture. Yet despite how widespread and beneficial these new interpretations are, the Catholic Church does not acknowledge most of them due to the "controversial" nature of these new identities.

"Controversial Saints: A Study in How Pop Culture Can Radicalize Religious Icons" is a study of one such figure, Joan of Arc. Her transformation from heretic to saint to nationalist icon of France is well documented and discussed within the realm of art history and modern media. She has however in recent times assumed the more "controversial" identity as a queer icon for lesbians and gender nonconforming individuals within the LGBT community. The result of these changes has sparked a long lasting debate over what the "true" identity of Joan of Arc really was and what her role in modern society should be due to how these aspects conflict with the dogma of the Roman Catholic church.

For my creative artifact I will be creating an animated digital painting which comments on this debate and addresses the conflict between the LGBT community and the Catholic Church. I will be using the digital painting software Clip Studio paint for the illustration aspect. For the animation, I will be using the software Live2D which is most often used to create Virtual Youtubers or VTubers for games and live streaming. The combination of these two technologies will result in a dynamic, constantly changing illustration that represents the ongoing debate over who Joan of Arc really is and how the modern digital landscape contributes to the evolution of her identity.

Subjects: Arts and Humanities, Creative Works

Correcting Forward Head Posture in Collegiate Dancers: Strengthening Versus Manual Release

Jordan Christie and Sydney Rutledge

Faculty Advisors: Carisa Armstrong and Christine Bergeron

Forward Head Posture **(**FHP) is described as a misalignment in the cervical spine that moves the head into the anterior space of the body and is often accompanied with rounded shoulders. As the use of technology and personal devices increases, the rates of FHP are also increasing. This common misalignment can cause damage to the spine, and ultimately lead to increased risk of injury to the lower body. Correct posture is the first defense against injury in dancers. In addition, dancers with FHP and RS are not aesthetically acceptable according to dance technique standards. Therefore, this study will impact dancers who want to improve their posture. There is currently a lack of research and data on FHP in dancers. This study will provide more information on FHP in a dancer specific population. The main goal is to determine if strengthening or manual release techniques will have the greatest improvement in decreasing the degree of forward head posture. This study utilized intervention sessions to manipulate change in FHP and RS. Participants were recruited and randomly divided into three groups: Strengthening, Manual Release, and Control. All groups participated in the pre-test and post-test which included the FHP & RS survey, a postural analysis, and FHP was

measured with a goniometer. During the 8 weeks, the intervention groups attended 3 intervention sessions each week. The strengthening group utilized TheraBands and a Pilates tower to complete Pilates based exercises. The exercises increased in repetitions and resistance weight over the course of 8 weeks. The manual release group utilized a pinky ball and combination of stretches to release the trapezius, pectoralis muscles, and posterior occipitals. At the end of the study all participants in the intervention groups had decreased their degree of FHP. More statistical analysis is to follow.

Subjects: Education, Science (STEM)

Decolonizing the American Family Unit

Kate Girvin

Faculty Advisor: Omar Rivera, Ph.D.

Decolonial feminist Maria Lugones identified how colonial determinations of gender and race affect the positionality of women of color through her critique of modern/colonial social formations in America. Lugones has recognized that Western attitudes have reconstructed American society to exclude persons found outside of the dominant social organization. Additional research in decolonial theory and other relevant feminist philosophy texts will support evaluations that suggest that modern/colonial attitudes towards race and gender have imposed social and political norms that subordinate women of color and mothers in particular.

I will adopt a decolonial feminist approach to the evaluations of American family units, particularly family units of Texas borderlands, and will analyze how family dynamics found outside of the dominant social organization refute social determinations of gender and race. Concepts such as arrogant perception of women, fragmentation, and capitalism will help to explain how women of color are reduced in society and within the family unit, specifically through attempts to impose corresponding social relations.

A recognition of the struggles against dominant social classifications endured by women of color will explain how the positionality of women in society is centered upon being subordinated by white men. The family unit is a source of struggle that reinforces the self-estrangement of mothers as objects of an oppressive arrogant perception. This paper will address the gap in decolonial feminist literature to expand upon a decolonial viewpoint that the nuclear family is a microstate. Thus, families in the borderlands must reject European centered feminism in America, as it misses the colonial perspective. Instead, families in the borderlands navigate through society by embracing their double-consciousness and multiplicity. An analysis of the dialogues of Lugones and other feminist philosophers will contribute to conversations of this counterculture, one which identifies the fragmentation of women of color in the family unit and the mechanisms of colonial power that oppresses them.

Key words: Decolonial theory, deconstruction, multiplicity, identity, mind-body problem, capitalism, primitive accumulation, double-consciousness, borderlands

Subjects: Arts and Humanities

Deep Reactive Ion Etching Development with the Bosch Process

Marcelo Pier

Faculty Advisor: Arum Han, Ph.D.

The Bosch process is a type of deep reactive-ion etching (DRIE) of silicon. It is a type of plasma etching, or dry etching, that uses physical and chemical processes to etch the surface of a silicon sample. Due to its highly desirable results, this process is used in several applications, such as nanoscale MOSFETS, microelectromechanical systems, and micro-optics.

This process is unique because it switches between process gases or plasma chemistries to create a fluorine base for etching while also creating a carbon layer for sidewall protection. The etching process cycles between etching with fluorine and depositing a carbon layer coat known as passivation.

In regular reactive-ion etching (RIE), there is possibility of rough sidewalls, low aspect ratio, and growth of silicon grass at the bottom of the feature trench, some of which can be as tall as the etched feature itself. Thus, the Bosch process is a highly effective procedure that results in higher etch rates than regular RIE. In addition, it enables selectivity and anisotropy and eliminates the possibility of silicon grass formation in etched trenches. The most desirable aspects of this process are its abilities to etch while maintaining smooth sidewalls and produce high aspect ratio features with vertical sidewalls.

The Bosch process for deep reactive ion etching will be implemented on an Oxford Plasmalab100 ICP RIE machine. Throughout development, thin film deposition, thermal oxidation, photolithography, silicon dicing, wet etching, and cross-sectional scanning electron microscopy processes will be used.

Subjects: Engineering (STEM), Technology (STEM)

Deep Reinforcement Learning for Mobile Robots

Vince Potter

Faculty Advisor: Dileep Kalathil, Ph.D.

This project investigates the use of model free deep reinforcement learning algorithms for navigating robots within indoor settings. Model free autonomous navigation is an important area of research because it has applications in exploration, surveillance, search and rescue and other dynamic environments. The robot being used is a TurtleBot3 Burger. It does not contain a map of the environment as it learns to reach desired waypoints. Using a neural network and a TRPO policy, the current state/position of the robot is determined from onboard sensors and a subsequent action is output. The action controls the velocity and steering angle of the robot. Models are trained sufficiently in a simulator using a dense reward structure before being deployed onto the physical robot for analysis. This project utilizes a custom Dubins environment and Gazebo for simulated training. In the simulator, the robot learns how to navigate between fixed or randomly generated waypoints until reaching a final goal. An optimized reward function produces accurate responses from the robot allowing it to reach several sequential waypoints in a timely manner. Next, sparse reward environments will be explored for obstacle detection. This requires improvements to the reinforcement learning policy and incorporating data gathered from a LiDAR sensor.

Subjects: Engineering (STEM)

Designing a Dry Gas Seal Dynamic Test Bench

Fatin Abbasher, Seham Al Baker, Mohamed Fattouh, and Ryan Mansour

Faculty Advisor: Bilal Mansoor, Ph.D.

Centrifugal compressors take in large volumes of gases, some of which are toxic and extremely dangerous. To contain these gases and avoid any leakages from taking place, dry gas seals are utilized. Dry gas seals need to be maintained and tested regularly, so designing a reliable testing system for the dry gas seal is very important to ensure a safe working environment in the company. This project focuses on designing a dry gas seal testing bench that needs to follow API 692 standards such that it runs certain testing conditions on the dry gas seal and measure gas leakage rate during the operation. The main requirements of the test bench are to rotate the shaft in the seal up to 6000 RPM, to supply gas with pressure up to 220 bars, to withstand a temperature of 0- 220°C and to be able to measure gas leakage rate up to 15 scfm and to ensure a safe operation.
The main components of the test bench have been chosen, but the design is not yet complete as it need more details and analysis.

Subjects: Engineering (STEM)

Dialogue Based Evaluation of Conversational Taskbots
Timothy Feldman

Faculty Advisor: James Caverlee, Ph.D.

The increasing popularity of intelligent systems has led to the rise of new types of conversational agents. Some of these systems are classified as task-oriented dialogue systems, or taskbots. Previously, these systems focused primarily on completing digital tasks such as booking a hotel, or technical support. With the Alexa Challenge, University teams across the world have the chance to design conversational taskbots which assist users with physical tasks such as cooking or DIY tasks. We use data from conversations between our bot and real users to determine the factors which determine the quality of a conversation with a taskbot. We then use these factors to construct models which classify conversations based on predicted quality. We find that several factors are correlated with conversation quality, and that those factors can be used to predict the quality of a conversation. We also find that our conversational taskbot has predictive features more similar to chatbots than to previous task-oriented dialogue systems. These results give insight into what factors users value in a conversation and reveal that conversation quality is not entirely determined by task completion. The predictive models developed in this work can help correct negative conversations as they happen and provide a baseline for the evaluation of future taskbots.

Subjects: Engineering (STEM), Technology (STEM)

Distributed Filtering Solutions for Addressing Power Quality Issues in Distribution Systems with High EV Penetration Levels
Nicolas Elizondo

Faculty Advisor: Irfan A. Khan, Ph.D., P.E., SMIEEE

With the ever-increasing popularity of EVs and addition of dynamic distributed generators, such as solar panels in homes, the conventionally designed utility grid is facing issues like overloading and stability concerns including power quality issues, such as harmonics and voltage sag/swell, at all the

nodes in the grid. With EVs being mobile and random, an extra layer of complexity is added to the already dynamic system. In this research, I'm focusing on addressing the power quality issues (harmonics), while attempting to accurately model the randomness and mobility of EVs in a low-voltage distribution system. Active filters connected in parallel to each harmonic load have arisen as the best solution for conventional and radial grids. However, these filters are large and expensive, so finding a solution that minimizes harmonics below required levels at a reasonable cost requires proper modeling and simulation. To address these concerns, my research will present a novel filtering solution that will optimally place the active filters throughout the electric grid. To benchmark the problem statement and define the proposed algorithm, a detailed modeling study with a generic IEEE 33-node system (with industrial, commercial, and residential sectors) attempting to mimic a Texas grid is used. To account for the randomness of the EVs, probability mass functions based on the power available in each node are used. The proposed philosophy that is being defined as the research progress will have the capability to be repeated with any grid system to fit a variety of needs. In the Symposium, I will demonstrate the progress of my research, which will showcase the completion of the defined grid system and the PMF's that will be used in the in-progress optimization algorithm.

Subjects: Engineering (STEM), Technology (STEM)

Do Candidate Genes Distinguish Migratory and Nonmigratory Avian Species?

Olivia Lennon

Faculty Advisor: Kira Delmore, Ph.D.

Migration is a behavioral syndrome that integrates morphological, behavioral and physiological traits. This syndrome exhibits considerable variation within and between species. This variation in migratory behavior has been demonstrated to have a heritable component, and several candidate genes have been identified in previous studies that are linked to migration. The candidate gene approach seeks to uncover genes responsible for variation in migratory behavior by using prior knowledge of characteristics of genes and characteristics of migratory traits. Here, I reviewed the recent methods of candidate gene studies related to migration using the Web of Science database and generated an updated list of likely candidates for this study and future studies. The literature search generated 458 candidate genes, which were then used to analyze evidence of positive selection among migratory and nonmigratory lineages. The dataset used included 13 species in the *Catharus* genus, including both migratory and nonmigratory species. To investigate whether one or multiple of these candidate genes is linked to the migratory versus nonmigratory behavior, I extracted genomic alignments for these genes and performed a dN/dS analysis of diversifying selection on migratory versus nonmigratory species. Eleven candidate genes exhibited evidence of positive selection in migratory species, however, there is not significant evidence of a relationship between the significant candidate genes and migratory behavior. This study demonstrates the applicability of using results from published literature to analyze patterns in migratory candidate genes between species.

Subjects: Science (STEM)

Dynamic Voxel Entities in Minecraft

Rebecca McFadden

Faculty Advisor: Shinjiro Sueda, Ph.D.

Minecraft is 3D voxel sandbox game where players can explore infinite terrain, build blocky structures, collect resources, and more. Most things in the game are placed on an axis-aligned grid, however, some things such as players, non-player characters (NPCs), and other entities can maneuver and collide with the world in a non-axis-aligned manner. These entities have specifically defined geometry and collision boxes. While the geometry of an entity can change as a result of its state, there is no ability for a player to directly destroy a part of an entity's geometry. The goal of this project was to investigate deformable block-based actors/entities in Minecraft and create a system for handling multiple voxel grids in Minecraft to allow for these movable, deformable, entities to collide and interact with the world. Since these voxel grids needed to be able to collide with the core grid and each other, several techniques for bounding boxes were reviewed and discussed. The picking algorithm was also adjusted to allow each voxel grid to determine which block is interacted with by a player. In addition, this project proposes a prototype of the system necessary to create the block entity models, collide them with the world, and dynamically change the structure of the models.

Subjects: Technology (STEM)

Early Prediction of Mortality Rate using Common Vital Signs

Naveed Khimani

Faculty Advisor: Bobak Mortazavi, Ph.D.

The purpose of this paper is to employ baseline, commonly taken vitals in order to predict hospital mortality early on into a patient’s stay. In the past, it has been seen that clinical informatics implemented in medical practices can have drastic improvements upon the care provided to patients. With a complex analysis of a given patient upon admission based upon routinely taken measurements, medical professionals could better allocate resources to provide the best patient care.

In order to accomplish this, four vitals, Heart Rate, Respiratory Rate, Blood Pressure, and Temperature were extracted from the MIMIC-III database at admission for over 16,000 patients along with whether they survived the hospital stay. These four numerical features were supplied to an XGBoost model, an advanced Decision Tree Classifier that employs gradient boosting. Because of the imbalanced data, the positive values were weighted roughly 10x as high to equate the decreased frequency.

The model demonstrated an 82% accuracy with a Precision-Recall of 0.812 and a ROC-AUC of 0.956. Additionally, the model also showed that temperature was the most impactful feature in terms of the accuracy gained by its inclusion. Based on these quantitative results, it is likely that the model is overestimating the negative classification (survival) because the general pattern is that most people survive. Some ways to further improve this research are to hyper-tune the parameters with GridSearchCV, incorporate early time-series data for the features, and interpret with an external library such as SHAP.

Subjects: Engineering (STEM), Health and Medicine (STEM), Technology (STEM)

EBNA1 vs LANA Relative Binding Free Energy from Molecular Dynamics Simulations

Sarah Fross

Faculty Advisor: Wonmuk Hwang, Ph.D.

The Epstein-Barr virus (EBV) and Kaposi's Sarcoma-associated herpesvirus (KSHV) are prevalent worldwide with a 95% infection rate for EBV in adults. These herpesviruses code for DNA Origin-Binding Proteins (OBPs) such as Epstein-Barr Nuclear Antigen 1 (EBNA1) in EBV and Latency-Associated Nuclear Antigen (LANA) in KSHV. Both of these OBPs are responsible for oncogenic conditions (Hodgkin's lymphoma, Kaposi's Sarcoma, gastric cancers, etc.) as well as episome maintenance during latency phases, making them attractive targets for inhibitor therapy. This study focused on understanding the atomic interactions between EBNA1, LANA, and their corresponding viral DNAs (vDNA) using Molecular Dynamics simulations of the EBNA1-vDNA^{EBV} and LANA-vDNA^{KSHV} complexes. Our analysis calculates Relative Binding Free Energies allowing for a comparison to be made between EBNA1 and LANA. With these calculations, ligands can be synthesized to bind specifically to the DNA Binding Domains on these OBPs to inhibit function of EBV and KSHV.

Subjects: Engineering (STEM), Science (STEM)

Effect of Climate and Land Use on the Spatial Distribution of Ehrlichia chaffeensis Infections

Esha Kothapalli

Faculty Advisor: Hsiao-Hsuan Wang, Ph.D.

Recent studies have shown that geographic ranges of ticks and tick-borne diseases are increasing. Changes in climate and land use have been shown to increase the incidence of tick-borne diseases. *Ehrlichia chaffeensis* infection is an emerging tick-borne disease caused by *Ehrlichia chaffeensis* in the United States. *Ehrlichia chaffeensis* infection causes nonspecific flu-like symptoms and can be potentially fatal in humans. The trend of *E. chaffeensis* infection has been increasing since 2000. Hence, I aim to identify spatial patterns and detect hot spots of *E. chaffeensis* infections from 2012 to 2015 and examine the impacts of climate variables and land use factors on *E. chaffeensis* incidence. First, I collected the incidence data of *E. chaffeensis* infections, climate variables, and land cover land use data from the National Notifiable Disease Surveillance System, PRISM climate group, and the National Land Cover Database. I mapped and overlaid all data using ArcGIS. I analyzed the geo-referenced variables describing climatic conditions and landscape features to identify potential factors influencing the likelihood of incidence of *E. chaffeensis* infections using a multinomial logit model. Preliminary results indicate that the incidence of *E. chaffeensis* infections is more prevalent in the southeastern region of the United States.

Subjects: Health and Medicine (STEM), Science (STEM)

Effects of Composition Changes in Mn-PLGA Nanoparticles on Sustained Oxygen Production and Immune Activity In Cancer Spheroids

Daniela Osteicoechea

Faculty Advisor: Isaac Adjei, Ph.D.

Hypoxia is a common characteristic of the tumor microenvironment (TME) that suppresses immune responses and allows cancer cells to evade killing by cytotoxic cells. Sustained oxygen production in the TME is therefore of interest to improve the effectiveness of immunotherapies. Manganese

dioxide nanoparticles (MnO2 NP) react with available hydrogen peroxide (H2O2) in the TME to produce oxygen but is limited by toxicity and rapid oxygen production. We recently showed that encapsulating MnO2 in poly (lactic-co-glycolic) acid (PLGA) modified the kinetics of O2 production and decreased MnO2 toxicity. We hypothesized that the MnO2 toxicity and change in kinetics are mediated by the hydrophobicity of the PLGA which limits interaction with hydrogen peroxide. To test this hypothesis, MnO2 was encapsulated in PLGA with different hydrophobicities [50:50 (PLGA), 75:25 (PLGA), and 100:0 (PLA)], by double emulsion method. Increasing lactic acid content of the polymer increased the size of the NPs. Additionally, increasing the lactic content decreased the efficiency of MnO2 encapsulation with PLgA-MnO2 NPs with 3 percent wt Mn vs 4 percent for PLGA NP. Increasing lactic acid:glycolic acid ratios and hence hydrophobicity of the polymer decreased the toxicity of the NPs. Increasing lactic acid character increased sustained oxygen production. Future studies will explore changes in TME modulations, such as tumor hypoxia, with differing lactic acid character.

Subjects: Engineering (STEM), Health and Medicine (STEM)

Eliminating All Rapists from the Streets of Texas

Abigail Jablon

Faculty Advisor: Chaitanya Lakkimsetti, Ph.D.

This thesis project delves into the complexities of contradicting arguments regarding women's safety in the 87th Texas Legislative Session, focusing on Constitutional Carry and Domestic Violence Education. It is further determined how constructions of crime and public-private discussions impact policies which affect women disproportionately to men. As Dr. Jane Stoever has determined, "domestic deaths due to firearms are preventable" (Stoever 2019). However, policies continue to be passed which contribute to higher rates of domestic violence. It is important to apply the available research regarding gun violence statistics to the decision-making processes which lead to these harmful laws. Dr. Stoever determines that more regulatory gun policies could prevent deaths, and Dr. Jennifer Carlson focuses on how masculine constructions of crime are used by gun rights groups to push their agenda. I analyze how this translates to arguments being made by conservative legislators in favor of Constitutional Carry in Texas, citing concern for women, when the research suggests otherwise. Through the analysis of legislative discussions archived by the Texas Legislature, I conclude that women's struggles are used to maintain a patriarchal power structure, even if subconsciously, which does not reflect the reality of crime against women accurately.

Subjects: Arts and Humanities

EV Wireless Charger

Alyssa Brown and Teddy Lehman

Faculty Advisor: Oscar Moreira-Tamayo, Ph.D.

As electric vehicles of all sizes become more popular, the demands for convenient ways of powering them grow as well. Wireless chargers have become a preferred alternative to conventional wired chargers for their convenience and safety features. This thesis covers the design and testing of a wireless charger suitable for a small electric vehicle such as a E-bike. An inductive based power transfer is used along with key electronics including inverters, rectifiers, buck and boost converters. Another important element to this design is its ability to use either a DC or AC primary source. This makes the charger more versatile than single source designs by allowing for the choice of a power

grid connection or an off-grid power such as through a solar panel. The design process for all components will be discussed and followed with simulation results showing ideal performance. A prototype is also constructed to provide real life analysis of the design and to determine effects of misalignment and other magnetic interference. The results from this work will be compared with similar previous designs.

Subjects: Engineering (STEM)

Evaluating Daylight Lighting Appearances in Virtual Reality Environments

Grace Li

Faculty Advisor: John Keyser, Ph.D.

This presentation focuses on evaluating the effectiveness of various lighting appearances perceived by humans' perceptions in built environments within VR systems. Two methods for simulating user immersion in VR with daylighting are presented: (1) a 360º panorama view of the space at a particular point and then generating renderings from multiple different locations in the scene vs (2) a free roam method in which a texture is created for each polygon face in the scene. A user study is conducted to quantify user presence, perceptual impressions, and physical symptoms of users in the different daylighting methods being contrasted. The participants will complete a set of tasks within the VR environment pertaining to the lighting of the room. Out of the 35 participants, around half of the participants will start with the panorama simulation while the other half will start with the free roam simulation; the same set of tasks is repeated in the other virtual simulation. Results gathered will indicate whether there exists a significant difference in perceptual accuracy/awareness, physical symptoms, and perceived presence between the 360º panorama view method versus the free roam method. Following these findings, the presented results can lead to additional research in using virtual reality to simulate real environments when investigating the impacts of daylighting in spaces.

Subjects: Engineering (STEM)

Evaluating the Impacts of Climate Change on the West African Monsoon

Kerry Abernethy-Cannella

Faculty Advisor: Rodrigo Bombardi, Ph.D.

This project covers the impacts of climate change on the West African Monsoon system by using climate models to compare the regime of the late twentieth century to that of the late twenty-first century. We use spatial and temporal analysis to identify model biases and patterns, and use the existing literature to document and explain those patterns. Using a less arbitrary method of determining the delineations of the rainy season than much of the literature covering this topic, our analysis covers three variables: date of rainy season onset, rainy season demise, and total precipitation during the rainy season, hereafter referred to as onset, demise, and precipitation.

These variables allow us to structure the research into three gridded datasets: historical observations, satellite data from the thirty year period near the end of the twentieth century; historical model data, results of the numerical model ensemble applied to the same period; and future model data, the ensemble's prediction for the end of the twenty-first century. Because the models are using the atmospheric conditions from a representative concentration pathway characteristic of high greenhouse gas emissions, this dataset corresponds to the SSP5.85 (shared

socio-economic pathway) climate model. To ensure equal weight is given to each model for the purpose of bias and predictive analysis, regardless of the number of members of each, our methodology ensures that any statistics for the models are calculated separately and internally within each model.

Our findings indicate strong biases in demise and total precipitation, with a weaker bias relative to the predicted change in monsoon behavior for onset. However, in the context of the delay in the onset and demise, as well as an increase in precipitation, these findings are largely consistent with the literature.

Subjects: Science (STEM)

Evaluating the Inclusion of Environmental Justice and Equity Focused Curriculum in Environmental Programs at Minority-Serving Institutions

Corinne Buckley

Faculty Advisor: Ishara Casellas Connors, Ph.D.

Environmental justice is used to discuss how racial minorities and low-income populations are disproportionately impacted by environmental hazards and has become an important consideration when evaluating environmental concerns. Despite its growing relevance in environmental fields, the extent to which environmental justice topics are included in higher education is still unclear. Literature on environmental justice in higher education programs has focused primarily on what institutional factors contribute to its inclusion, while offering little about what specific topics are covered and the expected learning outcomes. This study utilizes a sample of 159 Minority-Serving Institutions (MSIs) to identify what environmental justice and equity curriculum is incorporated into environmental programs, determine whether this curriculum is required, explore the topics that are covered in relevant course, and analyze what differences exist between STEM and non-STEM focused environmental programs. The lack of inclusion of certain topics within curriculum may suggest to students that such topics are not essential. It is therefore important that students are educated on environmental justice and equity topics to better understand different perspectives and how environmental hazards and social change issues are connected. In addition, given the highly political nature of the environmental field, inclusion of environmental justice curriculum can help prepare students to face such issues in future careers.

Subjects: Education, Science (STEM)

Evaluation of the Effects of Intended Geographic Scale of Wayfinding Solutions on User Experience.

Isaiah Villagomez

Faculty Advisors: Daniel Goldberg, Ph.D., Tracy Hammond, Ph.D. and Paul Taele, Ph.D.

The purpose of this study was to identify the effects of attempting to complete wayfinding tasks utilizing geographic information systems that differ in intended geographic scale on users' perceptions of workload. A series of six wayfinding related tasks will be given to participants in which they will be asked to attempt to complete within a five-minute time period. These tasks differ primarily in terms of how granularly the data was related to the Texas A&M University campus. At the conclusion of an attempt participants will be asked how long they perceived to have taken for

the specific task and to complete an online NASA TLX questionnaire. Data analysis will then be conducted on user responses to the questionnaire and perceptual time inquiry to determine the statistical significance of the data gathered and whether or not a clear difference in user experience could be determined between the two systems. A difference in user experience is quantified as a statistically significant difference in a workload perception when attempting completion of one task utilizing a particular geographic information system over another. If a difference in user experience is identified, critical incident analysis will be conducted to determine the originating cause of the difference and whether or not it correlated with the systems differences between geographic scale. From this statistical and critical analysis, a set of design heuristics will be developed to guide the creation of wayfinding solutions in terms of considerations to be made in the context of geographic scale. Avenues for possible future research based on the conclusions of this study will be explored as well.

Subjects: Interdisciplinary Research, Social and Behavioral Sciences, Technology (STEM)

Evolution of Wave Packets under Semiclassical Approximations.

Spencer Ellis

Faculty Advisor: Stephen A. Fulling, Ph.D.

The purpose of this research project is to gain a visual understanding of wave packet behavior across various classical paths. Using previously computed propagators, as well a basic Gaussian wave packet, one can integrate the two quantities multiplied together to construct a quantum wave function. This work seeks to provide the reader with a visual demonstration of the complicated expressions derived in previous publications, and give physical meaning to these wave functions. Two different types of propagator expressions have been derived, one in terms of initial position data and another in terms of initial momentum data. For particular Gaussian initial data, we compute and compare plots of the two calculations to determine the regimes in which they are equal and the regimes in which one is favorable to the other. We also wish to vary the parameters of the Gaussian wave packets and examine the resulting behavior of the computed wave function. Previous work yielded solely formulas for these important quantities; this thesis aims to provide physical understanding of these quantities and gain insight how they respond under changing initial conditions.

Subjects: Science (STEM)

Extracting 3D Coordinates from Images Taken by Drones

Karim Zaher

Faculty Advisor: Robin R. Murphy, Ph.D.

When out on a search and rescue mission, it is important to have tools that can easily keep track of the situation that is being handled. Autonomous drones have the ability to quickly collect a batch of images of the scene and its surroundings in order to provide emergency responders with an overview of what they are dealing with. These images are also used to identify hazardous anomalies such as tiny cracks on collapsed buildings. In many cases, however, identifying the exact location of these anomalies may be too difficult, especially when the anomaly is relatively minuscule in size when compared to the structure that it inhabits. The conducted research focuses on developing a system which search and rescue teams may utilize in order to extract the exact coordinates of any

point found on an image taken by a drone. In order to do so, a series of images containing the scene of the area of interest is taken from a high altitude. Once that is completed, the images are loaded onto an application called Agisoft Metashape, where the images are combined in order to create a 3-dimensional orthomosaic. Finally, the Image Coordinate Point Extraction algorithm, which was created using Metashape's Python API, is run. The algorithm take in an image as an input, presents it to the user, and asks the user to click a point on the image to extract its exact coordinate. In the case of this study, the entire process was tested on data from the Surfside Condominium building collapse that occurred in the summer of 2021.

Subjects: Engineering (STEM), Technology (STEM)

Fabricating and Prevascularizing a Naturally-Derived Extracellular Matrix Scaffold: A Path to Permanent Cardiac Healing

Sameeksha Sharma

Faculty Advisor: Feng Zhao, Ph.D.

Cardiovascular diseases are a growing and grievous problem with limited therapeutic interventions due to the inability to replace scarred cardiac tissue. Nearly 60% of cardiac related deaths occur due to the accumulation of scar tissue precipitated by myocardial infarction (MI). Current therapies include the use of blood thinners, balloon stents, and whole heart transplants. These therapies serve to mitigate the problem rather than permanently addressing it because they do not restore lost cardiomyocytes (CMs) post-cardiac distress. The advent of stem cell research is changing the landscape of therapeutics since stem cells have a malleable identity and can differentiate into various cell types, including CMs. However, stem cells require a biologically complex environment that can provide them mechanical organization and biochemical cues that are crucial for survival, maturation, and integration. Naturally-secreted extracellular matrix (ECM) based scaffold meet these design specifications because they can closely mimic tissue microenvironments and promote dense vasculature growth which is imperative for a self-sustaining cardiac patch in order to enable permanent restoration of CMs which can dramatically improve cardiac function in cardiovascular patients. Therefore, the objective of this inquiry is to fabricate a natural and highly aligned ECM scaffold that can promote angiogenesis and support permanent cardiomyocyte restoration in the heart.

Subjects: Engineering (STEM)

Faculty World Travelling in the University

Maria Benavides

Faculty Advisor: Omar Rivera, Ph. D.

I am applying María Lugones theory of decolonial feminism to the experiences of Latina scholars in American universities. I want to learn how structures of race, gender, and power affect senses of belonging/marginalization to understand how Latinas negotiate historically exclusionary institutions. I will research university diversity inatitives and whether they have desired effects on campus culture. This is an important research since minorities are going into the American university, and have to go through what Lugones' describes as the "tension of their liminality" and "world-travelling '' where they balance academic life and personal history. Although the American University is trying to be inclusive, I want to explore whether these institutions are attentive to the "liminal" and

"world-traveling" work of faculty of color, and if there is added pressure for faculty of color to work more towards a university that doesn't advocate for them. Previous research has been statistical and about male scholars. My research route involves female scholars and uses Lugones' framework of balancing cultural identity, academic life, and success. I expect to reveal the balance between academic life and marginalized experience is an important component of underrepresented faculty's work, yet it remains insufficiently addressed in the institutional support they receive.

Subjects: Arts and Humanities, Social and Behavioral Sciences

Fairness and the Trusted Failure Detector

Ian Matson

Faculty Advisor: Jennifer Welch, Ph.D.

In 1985 it was shown by Fischer et al. that consensus, a fundamental problem in distributed computing, was impossible in asynchronous distributed systems in the presence of even just one process failure. This result prompted a search for alternative system models that were capable of solving such problems and culminated in the development of two helpful constructs: partially synchronous system models and failure detectors.

Partially synchronous system models seek to solve the problem of identifying process crashes by constraining the temporal behavior of the underlying system. In the resulting models, crashed processes can be detected indirectly through the use of timeouts. Failure detectors, on the other hand, address process crashes by directly providing (potentially inaccurate) information on failures.

These two constructs share a few key similarities- the most prominent one being that they allow the identification of crashed processes. This intuition was formalized by Pike et al. through the concept of *fairness*. Fairness in a system imposes bounds on the relative speeds of communication and execution between processes in a system, and it was shown that four frequently-used failure detectors from the Chandra-Toueg hierarchy (*P,P,S,S*) encapsulate these fairness properties. This discovery enables the extensive time and effort spent pursuing the weakest failure detectors capable of solving various problems to be applied to partially synchronous system models as well.

In this thesis, we will be discussing extensions of the Pike et al. result to two additional well-known failure detectors, the trusting failure detector (*T*) and the quorum failure detector (*Σ*). The trusting and the quorum failure detectors are the weakest to implement fault-tolerant mutual exclusion and consensus, respectively, which are fundamental primitives for distributed computing.

Subjects: Engineering (STEM), Science (STEM), Technology (STEM)

Farmworkers as Heroes for COVID-19 Mitigation: Curriculum Development, Implementation, and Evaluation of Sé el Héroe (Be the Hero)

Efrain Amaro

Faculty Advisor: Joseph Sharkey, Ph.D., MPH

Background: Migrant and Seasonal Farmworkers (MSFW) are at heightened vulnerability for SARS-CoV-2 infection and transmission due to their occupational and lifestyle exposure. Furthermore, the

high levels of cardiovascular and pulmonary diseases among the community also contribute to their vulnerability.

Purpose: The purpose of Sé el Héroe is to create a culturally and linguistically responsive outreach program by developing, deploying, evaluating, and disseminating a curriculum with the goal of mitigating the infection and transmission of SARS-CoV-2. The program seeks to do this by providing the necessary tools and training to Community Health Workers/*Promotores (P/CHW)* to gain the necessary knowledge, skills, attitude, self-efficacy, and behaviors to promote a positive change in the community.

Methods: In order to execute the purpose of the Sé el Héroe outreach program a formative evaluation for curriculum development was conducted, pilot testing then followed in which further modifications were identified to ensure program success, and finally program implementation.

Expected Outcomes: By establishing good rapport and relationships with the community and with *Promotoras,* it can lead to adoption of mitigation strategies and positive behavioral changes way beyond the timeframe of the program. It is expected for these efforts to benefit and strengthen the knowledge and skills of P/CHWs to further empower the resident of the communities. Ultimately, this can provide interactive education and skill-building through outreach efforts at the local, state, and national organization level to benefit a diverse demographic of P/CHWs.

Translation to Health Education Practice: The Sé el Héroe outreach curriculum program can provide insight on the importance and effectiveness of creating a program that takes into consideration the culture and language of the target community.

Subjects: Social and Behavioral Sciences

Fashion Consumer Motivations on Purchasing Sustainable Clothing

Avery Piwonski

Faculty Advisor: Keith Wilcox, Ph.D.

The recent development of conscious ethical behavior within the realm of consumption has created a new realm for fashion creators and consumers alike, the sustainable fashion market. This form of production provides insight that is otherwise overlooked, discussing moral values, and posing the question of whether clothing production is wasteful and polluting to the environment and public health. This study serves to investigate this new trend of sustainable fashion that is sweeping all platforms and determine what is the purchasing motivations for its consumers. Ethical and social implications are explored, something that has not been done in conjunction before, in order to aid companies in producing responsibly by creating what is most in demand for consumers. Everyday shoppers were surveyed using Amazon MTurk and the Qualtrics survey system in order to pinpoint these motivations when compared to demographics and age ranges. From this data, purchasing criteria and personal values will be able to contribute to the decisions of sustainable fashion producers, thus pushing the industry towards a higher standard of sustainability.

Subjects: Arts and Humanities, Social and Behavioral Sciences

Fast Graphlet Transform in GraphBLAS

Tanner Hoke

Faculty Advisor: Tim Davis, Ph.D.

Classically, many graph algorithms in computer science operate on representations of graphs other than the adjacency matrix. For example, the breadth-first search and many more complex shortest-path algorithms most often use an adjacency list representation of a graph. They also often involve iterating through some data structure which stores the current frontier of the search. However, many graph algorithms have dual implementations and perspectives involving linear algebraic operations on adjacency matrices. Approaching graph algorithms in this way comes with many advantages, including performance, ease of implementation, and code readability. GraphBLAS is a standard which provides a suite of building blocks for implementing graph algorithms using a linear algebraic approach via sparse matrices. Fast Graphlet Transform is an algorithm which detects graphlets, or subgraphs with small numbers of nodes, in a larger graph and describes the structure of the graph by determining the count of various types of graphlets adjacent to each vertex. In this presentation, we will provide some background on a linear algebraic perspective to graph algorithms and demonstrate its power by discussing the process of building the Fast Graphlet Transform algorithm for LAGraph, a library of graph algorithms built on top of GraphBLAS.

Subjects: Mathematics (STEM), Technology (STEM)

Flow System for 3-D Imaging and Quantitative Analysis of Stem Cell Cultures on Microcarriers

Roger McNichols

Faculty Advisor: Kristen Maitland, Ph.D.

Human mesenchymal stem cells (hMSCs) have been found to be a potential treatment for heart disease, diabetes, and stroke. As the prevalence of stem cell therapies increases, methods of production must be ready to meet this higher level of demand. This research focuses on the development of a 3D imaging flow cytometry (IFC) system for assessing the viability of hMSCs. This IFC system poses many benefits over traditional stem cell assessment procedures such as greater throughput, increased consistency, and decreased labor requirements.

The focus of this research will be creating a flow system that moves the microcarriers through the imaging plane and determining its efficacy. The system is run through a Raspberry Pi and can be fully operated remotely. This allows the user to set parameters for the fluid flow such as flow rate and duration and start the system at any time. The system is also equipped with a photodiode that triggers the camera as the microspheres approach, removing extraneous photo capturing and saving drive storage.

The final system was successful in producing laminar flow through the imaging plane and allowing for sufficient image quality. The maximum flow rate of the system is 3 mL per minute through the 0.9 x 0.9 mm microfluidic channel where the images are captured. Both computational and physical tests have demonstrated the flow system's ability to achieve ideal conditions for imaging even at high output levels. While the other components are still under development, these results show that a 3D IFC system with microsphere-based cell cultures and deep learning image analysis may be a viable solution for the monitoring of hMSCs during production.

Subjects: Engineering (STEM), Health and Medicine (STEM)

Formation of Quasi-Static Bandgaps in a Novel Metamaterial: Simulation and Experiment

Muhammad Nafees

Faculty Advisor: Sami El-Borgi, Ph.D.

This research aims to design a novel metamaterial capable of generating a quasi-static bandgap from zero frequency. Bandgaps have been studied extensively as they are imperative in developing vibration suppressing devices. However, the formation of quasi-static bandgaps is still quite limited and remains an essential topic in metamaterial-based vibration suppression. Structures like buildings and piping networks tend to have extremely low natural frequencies of 0-10 Hz. To suppress these ultra-low vibrations, quasi-static bandgaps need to be achieved. Few metamaterials that can achieve quasi-static bandgaps have been proposed and studied analytically and numerically. However, they have never been fabricated or tested experimentally to the best of our knowledge.

The metamaterial is modeled by a lattice system made of mass-in-mass units. The unit cell of the proposed metamaterial contains a resonator connected to a bar-spring mechanism embedded in a host mass. The new metamaterial's bandgap behavior is investigated by using Dispersion Curve Analysis using COMSOL Multiphysics, a commercial FEA software. Initial results show the presence of a low-frequency bandgap. By changing parameters and adding low stiffness material to the perimeter of the resonator mass, the author hopes to achieve an Ultra-Low bandgap.

Subjects: Engineering (STEM)

Friction Stir Processing - Enhancing the Mechanical Properties of Magnesium

Haseeb Bajwa and Hayyam Iqbal

Faculty Advisor: Bilal Mansoor, Ph.D.

Magnesium is one of the most abundantly found materials in nature. Its use in the industry extends to a vast majority of fields leading from manufacturing small luxury items to industries as big as automobile or aerospace. In the present work, we are testing WE43 Mg alloy sheets joined together by friction stir welding (FSW) for mechanical properties. We have used tensile and hardness tests. The study comprises two hardness tests, Nanoindentation and Vickers hardness test. The Nano-indentation test will also allow us to obtain data on other mechanical properties such as the Young's Modulus of elasticity using Oliver Pharr's method, integrated as an analytical model inside the machine. Two samples will be used. One will be the base metal, while the other is the welded metal sheet, and these two will be compared for microstructure, strength, and hardness. The microstructure analysis will determine the cause behind the change in properties. This research will demonstrate the effects of FSW/FSP on WE43 alloy.

Subjects: Engineering (STEM)

Genetic Sex Impacts How Prenatal Alcohol Exposure Induces Early Expression of Astrocyte Markers in Neural Stem Cells

Aubrie Miller

Faculty Advisor: Rajesh C. Miranda Ph.D.

Prenatal alcohol exposure (PAE) can adversely affect growth and neurodevelopment and lead to fetal alcohol spectrum disorders (FASDs). Previous research in the lab has shown that PAE lowers the number and variety of neural stem and progenitor cells in the brain, in part, through premature maturation. The transcription factor nuclear factor-1 A (NFIA) has been shown to be necessary and sufficient for gliogenesis and, therefore, likely plays a role in PAE-induced premature maturation of neural stem cells (NSCs). Here, we examined the impact of PAE on NSC NFIA expression and the role of genetic sex in modifying these effects. Using an in vitro NSC culture model, composed of neurosphere cultures, we used RNA sequencing and proteomics to determine neurosphere NFIA expression. We found no differences in the expression of Nfia mRNA following ethanol exposure, but we did find significantly higher levels of NFIA protein (~36%) in male neurospheres. We also found that NFIA was abundantly present in NSC-derived extracellular vesicles (EVs), a mechanism of paracrine signaling. In contrast to the intracellular expression, that female NSC-derived EVs had significantly higher levels of NFIA (~125%). These sex differences in NFIA protein expression were decreased with increasing levels of ethanol exposure. We are further exploring how sex impacts the cellular localization and trafficking of NFIA using subcellular fractionation and immunoprecipitation. These data indicate that there may be an underlying sex difference in ability of NSCs to undergo gliogenesis and that PAE-induced premature differentiation of NSCs may be neurogenic as opposed to gliogenic. Further investigation is needed to understand the mechanisms that underlie these sex differences in NFIA expression.

Subjects: Health and Medicine (STEM), Science (STEM)

Graph Neural Networks for Computational Chemistry

Bora Oztekin

Faculty Advisor: Shuiwang Ji, Ph.D.

Graph Neural Networks have been behind many pharmacological breakthroughs due to their innate ability to learn structural properties of molecules and accelerate high-throughput screening for favorable characteristics that could serve as a treatment or cure to a disease. Much of the world's natural data, such as social networks and molecules, can be represented in the form of graphs. However, advancements in graph-based problems like chemistry have been lacking. This is because graphs are a form of non-Euclidean data, and encoding them into a format that is compatible with deep learning is considerably more challenging. This thesis seeks to understand and benchmark the techniques used to preserve the structure and properties of a graph in the encoded form. Specifically, characteristics of a graph that are distinct in the graph form should be distinct in the encoded form. Preserving both the expressiveness and the distinctness of the encoded graph is a challenging task that has received a lot of attention in geometric deep learning. This work evaluates and compares various 2D and 3D graph neural network methods on a large public dataset to quantify the expressive power of more detailed graph neural networks that consider dihedrals and bond information, for example. It becomes evident that simply constructing homogeneous graphs of nodes and edges is insufficient.

Subjects: Engineering (STEM)

Habitat-Lab Quadruped Implementation

Scott Steinhauser

Faculty Advisor: Dylan Shell, Ph.D.

With the rise of reinforcement learning, a number of physics engines and frameworks have been used to simulate virtual environments. Additionally, various benchmarks have been popularized in order to assess the ability of RL algorithms to learn from these environments and produce effective policies for agents to act on. In this project, we aim to replicate a popular reinforcement learning benchmark, Open AI's Ant-v2 environment, in the AI Habitat platform and apply Proximal Policy Optimization to train a quadruped robot to run on a platform. Doing so allows us to extend the standard benchmark by adding visual sensors to the robot and including more complex environments such as indoor spaces.

Subjects: Engineering (STEM), Interdisciplinary Research, Science (STEM), Technology (STEM)

Heart Rate Variability as a Biomarker for Working Memory Performance and Fatigue Perception

Yixin Zhang

Faculty Advisor: Ranjana K. Mehta, Ph.D.

Fatigue is a debilitating and hazardous psychological phenomenon, especially in the emergency response (ER) domain. Typical countermeasures, such as caffeine, do not address the root of the problem due to the complex nature of fatigue. To derive personalized and task-specific remedies, fatigue needs to be quantified by certain biomarkers. Previous studies have found significant associations between heart rate variability (HRV) and various prefrontal neural responses, while also suggesting HRV as an indicator of cognitive performance level and working memory [1].

We take data from a study done by our group [2] that investigated the use of transcranial direct current stimulation (tDCS) as a fatigue countermeasure. The study implemented a repeated measure, counterbalanced Latin square design where participants were randomly grouped under control, sham or anodal conditions. Subjective responses, WM performance, and HRV data were recorded. We hypothesize that: (1) individuals with higher resting-state HRV will exhibit better performance and report lower levels of perceived fatigue; and (2) decrease in HRV during tasks will be associated with a concurrent decrease in performance and (or) an increase in fatigue perception.

This study intends to unveil the relationship between HRV, WM performance, and fatigue perceptions. We will investigate the relevance of resting-state and time-on-task changes in HRV on reflecting fatigue perceptions and task performance during the WM exercise. Ultimately, we aim to provide an unobtrusive measurement of fatigue using HRV that will contribute to personalized fatigue countermeasures.

Subjects: Engineering (STEM)

How Chapter 313 Effects School Districts and Solar Energy Expansion

Victoria Cooper

Faculty Advisor: Christian Brannstrom, Ph.D.

The development of solar energy in Texas began to increase rapidly in 2020, quickly catching up with California, the nationwide leader. Already the nation's top wind energy producer, solar energy is expected to make up the largest share of Texas's energy capacity additions between 2020 and 2022.

This recent rapid increase is an ongoing trend that presents a unique opportunity to evaluate solar energy's impact on Texas economically and environmentally compared to fossil fuel-generated energy. In 2001, Texas implemented Chapter 313 in the Texas Tax Code to encourage businesses to develop new capital investments in school districts. Chapter 313 is a state tax incentive for companies to invest in developing large-scale investment projects on a school district's property in return for a limitation on the value of their taxable property for ten years. Large-scale manufacturing followed by wind energy farms were the majority of the first projects. However, in 2013, the first solar energy project began, and solar projects now account for 26% of all active agreements and an even more significant portion of pending applications. This increase in solar energy project applicants under Chapter 313 since 2013 makes for an interesting trend in how the incentive has affected the expansion of utility-scale solar energy in Texas- specifically the rapid increase since 2019. Chapter 313 prioritizes investment in rural and disadvantaged communities with a lower threshold for investments in communities with a higher-than-average unemployment rate, lower-than-average income, low real estate values, and lack of commercial development. These agreements result in millions of dollars for these school districts. Using the data from Chapter 313 agreements since 2003 and comparing the trends, our research focuses on how Chapter 313 projects have and will continue to substantially impact the future expansion of solar energy, developing school districts, and green-job and green-economy expansion in Texas as we transition to cost-effective forms of carbon-free, sustainable energy.

Subjects: Science (STEM)

Hydrogel Microparticles as a modular platform for 3D Bioprinting

Jeremy Thomas

Faculty Advisor: Akhilesh Gaharwar, Ph.D.

Type-1 diabetes is a chronic condition in which the pancreas produces little or no insulin, caused by the destruction of the insulin-producing beta cells of the pancreas. Traditional strategies for treating type-1 diabetes, involving beta-cell transplantation or delivery, have shown mixed results due to loss of cell viability and decreased efficacy. Three-dimensional (3D) bioprinting, which fabricates scaffolds and extracellular matrices with living cells, has shown potential to circumvent some of these challenges and meet the needs for tissue engineering and cell delivery. In this work, we expect to design a modular bioink consisting of hydrogel microparticles and cell compatible polymer which will aid in effective delivery of insulin-producing beta-cells through a customized bioprinting approach.

Subjects: Engineering (STEM)

I-V Curve Tracer Communication Protocol

Maria Khan and Swati Singh

Faculty Advisor: Robert S. Balog, Ph.D.

This thesis aims at developing a communication protocol for an I-V Curve Tracer. The IV Curve Tracer consists of a Raspberry Pi as the central unit to which a Source Measuring Unit (SMU) and a Relay Board is connected via USB and Ethernet, respectively. The SMU measures the I-V curve by generating a voltage sweep and measuring the resulting current. The relay board enables testing of multiple specimens. We include an Arduino Mega in this set up to accelerate the communication

interface between the Relay modules and the Raspberry Pi. Therefore, our project aims to address the challenge of a scalable, low latency communication between the Pi-Arduino-Relay interface. Each Arduino is connected to one or multiple relay modules that are used to configure the interconnection between a single measurement device and various combinations of multiple PV cells in a current-voltage curve tracer (IVCT) testbed. This is significant because the time taken to complete a battery of tests using previous methods is over 15 minutes. However, an initial timing analysis found that the majority of the testing interval was spent on the communication to setup the relay configuration, not on the actual measurement process and hence, caused the relay boards to be slow to respond. This significantly limited the ability of the IVCT to scale-up in number of DUTs and complexity of interconnections tested.
Our project seeks to overcome limitations of the current technology by significantly reducing the packet size of the transmitted data and eliminating the bloated and slow IoT platform. The expected outcome is a lightweight communication platform that is flexible and scalable with fast messaging not just for the IVCT testbed but also suitable for other research laboratory automation and control.

Subjects: Engineering (STEM)

Identifying the Etiology of Post-Acute Sequelae SARS-CoV-2 (PASC) Infection

Perri Marshall

Faculty Advisors: Ramesh Vemulapalli, Ph.D. and Christopher Lee, Ph.D.

The viral illness coronavirus disease 2019 (COVID-19) has infected millions worldwide since its initial discovery in late 2019. After recovering from the primary infection, many have found themselves suffering new, ongoing, or recurrent COVID-19 symptoms in a condition referred to as long COVID or post-acute sequelae SARS-CoV-2 (PASC) infection. PASC can target any recovered COVID-19 patient. Presently, little is understood regarding the etiology of PASC.

This literature review analyzes current theories of PASC development in humans after initial COVID-19 infection. An understanding of PASC's developmental mechanism will pave the way for better-targeted therapies to treat patients diagnosed with this illness. The diversity of PASC symptoms suggests multiple possible pathologic mechanisms. Several treatment routes may therefore be necessary to treat different symptom subsets.

Proposed PASC origin theories for discussion include: (1) organ damage from initial infection leads to PASC; (2) immune dysregulation during initial COVID-19 infection later manifests as PASC; (3) chronic elevated hyperinflammation causes PASC symptoms; and (4) latent SARS-CoV-2 remains in cells after COVID-19 infection. Preliminary evidence from scientific studies shows strong support for theories 3 and 4. The interplay between these theories reveal future study directions and implications. A deeper understanding of these PASC mechanisms of action allows progression towards treatments that directly attack the illness at its source.

Subjects: Health and Medicine (STEM), Science (STEM)

Image-based Relighting Using Implicit Neural Representation

Shuyu Wang

Faculty Advisor: Nima Kalantari, Ph.D.

Rendering a scene under novel lighting has been a problem in all fields that require computer graphics knowledge, and Image-based relighting is one of the best ways to reconstruct the scene correctly.
Current research on Image-based relighting uses discrete convolutional neural networks, which tend to be less fit-able to different spatial resolutions and take up massive memory spaces. However, the implicit neural representation solves the problem by mapping the coordinates of the image directly to the value of the coordinate with a continuous function modeled through the neural network. In this way, despite the changing of the image resolution, the parameters taken in by the neural network stay the same, so the complexity stays the same.

Also, the rectified linear activation unit (ReLU) based network used in current research lacks the representation of higher derivatives information. On the other hand, the sinusoidal representation networks (SIREN) provide a new way to solve this problem by using periodic activation functions. Hence, my research intends to leverage SIREN network in image-based relighting.

We based our image-relighting network on the SIREN network in the research by Sitzmann. Our method is to modify the SIREN network so that it takes in not only coordinates but also light positions. Then we train it with a set of input images depicting the same set of sparse objects in different lighting conditions and their corresponding light positions. We test our network by giving the network a new lighting position, and the result we aim for is to acquire a better representation of optimal sparse samples under novel lighting with high-frequency details.

In the end, we would run the test on our image relighting network. The results would be compared and analyzed.

Subjects: Engineering (STEM)

Impact Of Climate and Land Use on the Spatial Distribution of Rickettsiosis Incidence in the United States

Scott Clark

Faculty Advisor: Hsiao-Hsuan Wang, Ph.D.

Rickettsiosis is a tick-borne illness that is prevalent in the United States. It is primarily caused by transmission through its vector, *Rickettsia*, most commonly by arthropod bites. Rickettsiosis can be treated using the antibiotic doxycycline, but diagnosis of rickettsiosis is extremely challenging, and symptoms do not appear until approximately 1-2 weeks after transmission. Recent studies have found that climate change has a positive effect on rickettsiosis. However, land use effects have not been fully studied. In this study, the impact of climate and land use were further investigated to see how it impacts the spatial distribution of rickettsiosis in the United States from 2012 to 2015. Climatic and land use data were collected from years 2010 to 2015 and 2012 to 2015, respectively, and incidence data were collected from 2012-2015. The climatic data was collected from PRISM climate group, the land use data was collected from the Multi-Resolution Land Characteristics Consortium, and the incidence data was collected from the National Notifiable Disease Surveillance System. I then merged and analysed all geo-referenced variables describing climatic conditions and land use features to identify potential factors influencing Rickettsiosis incidence using a multinomial logit model. The preliminary results indicate that the highest incidence of rickettsiosis occurs in the southeast of the United States with most counties having 1-14 cases per year, and some having greater than or equal to 15 cases per year. More specifically, Arkansas' counties have the most populated incidence rates.

Subjects: Health and Medicine (STEM), Science (STEM)

Impact of Parental Alcohol Consumption on Fetal Brain Volume

Kathryn Kuczkowski

Faculty Advisor: Michael Golding, Ph.D.

Craniofacial patterning dysmorphology and central nervous system abnormalities are characteristic defects of fetal alcohol spectrum disorders (FASD), a range of disorders induced by exposure to alcohol during pregnancy. The teratogenic effects of maternal alcohol consumption during gestation have been recognized for many years by the scientific community but recent research has identified that there is a paternal contribution to the development of FASD as well. This experiment was designed to observe the effects that dual parental prenatal alcohol consumption has on fetal brain development using a mouse model. Mice were exposed to alcohol on a voluntary basis, using a solution of 10% ethanol and 0.066% Sweet 'N Low to increase the likelihood of consumption. The consumption rate of each mouse was recorded along with the treatment group they were assigned, to establish the variance in drinking level. In order to differentiate the contribution effects from each parent, a 2x2 factorial arranged mating system was used to establish treatment groups of no alcohol consumption, maternal alcohol consumption, paternal alcohol consumption, and dual parental alcohol consumption. Fetuses of each treatment group were collected on gestational 16.5 and analyzed against each treatment group. Fetal heads samples were collected from each group and scanned using a Scanco VivaCT 40 machine. Using Horos medical image viewer software, the brain volume to brain case ratio was observed, along with the ratio of the frontal lobe length and width relative to the braincase. Our group hypothesizes that the effects of dual drinking parents will be synergistic, and create more pronounced and severe abnormalities than in models where only one parent drinks.

Subjects: Health and Medicine (STEM), Science (STEM)

Improved LiFi Tracking System

Michael Garner

Faculty Advisor: Christi K. Madsen, Ph.D.

As wireless data transfer has grown more prolific, and the technologies that rely upon it more numerous and sophisticated, critical limitations of RF-band wireless communication schemes such as WiFi have become apparent. To mitigate these limitations and enable the continued growth of wireless device functionalities, Light Fidelity (LiFi) schemes that transmit data through modulating visible, infrared, or ultraviolet light are being developed. LiFi systems present many advantages over RF systems, including vastly improved data transmission rates, but also lower power consumption, higher security, and utilization of a much broader, unlicensed spectrum. Laser LiFi systems in particular hold promise for their exceptional speed and range capabilities. This however comes at the cost of lasers being highly directional and thus requiring more precise alignment. This gives rise to the need for a transmit/receive system wherein the transmitting unit can locate and align a laser with a mobile target, establishing a link over which data could be sent using extant multi-Gbps laser modulation techniques. Additionally, to be useful in real-world environments, such a system must be able to complete the acquisition procedure rapidly and be of a reasonable size to be installed in various indoor and outdoor locations. Finally, to be commercially viable, the tracking system would

need to be low-cost, and would benefit from using commonly-available components. To meet these needs and contribute to the field of optical wireless communications, I am developing a low-cost, compact, rapid infrared laser LiFi alignment and tracking system that can meet or exceed the aforementioned functional requirements and thus enable further development of laser LiFi systems.

Subjects: Engineering (STEM)

In-situ Monitoring of Magnetically Augmented Additive Manufacturing

Ronald Sellers, Christopher McCullough, Eduardo Gonzalez, and Adam Light

Faculty Advisors: Sarah Wolff, Ph.D. and Hui Wang, Ph.D.

Through advancements in technology over the last several years, additive manufacturing has become increasingly relevant in the creation of biomaterials and biomedical implants. Through additive manufacturing implants can be fabricated with increased design flexibility while simultaneously reducing cost and waste. Additionally, additive techniques allow the manufacturer to design and build highly customized implants unique to each individual. This increased flexibility allows for the production of complex porous structures with increased mechanical performance that can potentially match that of the surrounding bone structure. It is clearly evident then, that additive manufacturing has developed to the point of exceeding more common subtractive methods in the creation of biomedical components in many cases. This research is investigating several cutting edge technologies and methods for creating more effective implant materials, as well as increasing the precision of the manufacturing process. Firstly, direct energy deposition was used as a printing method in order to create composites of Ti64 with a layer of hydroxyapatite and Ti64 with a layer of stainless steel 316L. These composites are designed to maintain the strong mechanical properties of the Ti64 substrate and the superior biocompatibility of the surface coating. This is especially true for the hydroxyapatite which exhibits significantly higher biointegration over a given time when compared to the base Ti64. By observing the microstructure and testing the hardness of these printed composites, they were determined to be viable materials for use in future biomedical implant fabrication. In addition, parts were also manufactured while augmenting the printing process's precision by using magnetic alignment on the melt pool. By aligning the melt pool in this way, the melting of the metallic powder can be more controlled allowing for complex designs involving the internal porosity of a part. This research endeavors to improve the viability of additive manufacturing as a fabrication method for biomedical implants by addressing the two main design constraints: biocompatibility and bone-like mechanical properties.

Subjects: Engineering (STEM), Mathematics (STEM), Science (STEM), Technology (STEM)

Interannual Trends of Carbonate Chemistry at the Flower Garden Banks National Marine Sanctuary

Jose Martinez

Faculty Advisor: Kathryn Shamberger, Ph.D.

In 2016 there was an extensive bleaching event in the Flower Garden Banks (FGB) that had over 80% of the corals develop mortality on the Eastern Bank cap (Johnston et al. 2019). Bleaching events have happened before but this was the most extensive to have occurred in the FGB yet showing an increase in coral bleaching frequency and intensity. The FGB has over 50% coral cover making it the healthiest coral reef in the Western Hemisphere. This work investigates the possible reasons for the

2016 bleaching event and assess interannual trends for the FGB. Samples were gathered in bottles a year before the bleaching event and annually until 2018 using the standard carbonate chemistry method (Dickson, Sabine, Christian et al 2007). Samples were then analyzed in a VINDTA 3C system and post-processed through CO2SYS. Depth profiles and spatial plots from analyzed samples centered around the FGB were used to determine what factors caused the bleaching event. While studies have come out saying low dissolved oxygen concentrations and upwelling as the contributing factors for the 2016 bleaching event, no scientific consensus has been reached yet (Johnston et al. 2018 & Kealoha et al. 2019). This study emphasizes the need for more carbonate chemistry data as more research is needed to assess the natural variability of the GOM freshwater plume extension and effects.

Subjects: Science (STEM)

Investigating the Impact of COVID-19 on the First Year Eats Program

Jasmine Tran

Faculty Advisors: Alan Dabney, Ph.D. and Sumana Datta, Ph.D.

First Year Eats (FYE) is a program at Texas A&M University developed to lessen food insecurity and its impact on college campuses. Students in the program have been provided with various dorm room cooking lessons and food resources in a community kitchen. To assess the program's success, we have used student GPA as a measure of academic success and two surveys aimed at measuring mental health. The Perceived Stress Scale (PSS) and the University Belonging Questionnaire (UBQ) was used to measure stress levels and university belongingness, respectively. Students participating in the FYE learning community are compared with a population of learning community students not in FYE (NFYE). The first, second, and current cohort of students participating in FYE, were investigated. The results of the combined first- and second-year dataset revealed that underrepresented minorities and first-generation students in FYE had a statistically significantly higher GPA than similar students not in the program during the Spring semester of their first year. This difference in GPA was not found during the students' Fall semester, suggesting that the FYE program played a role in improving academic performance.

The FYE program continues to play a role in academic success and mental health for participants, despite the COVID-19 pandemic. Current students in the program revealed a statistically significant higher Fall midterm GPA for students within FYE compared to NFYE students. Regarding early PSS and UBQ survey analysis, FYE students in Fall 2021 had a higher level of belongingness than NFYE students. Although the findings were not significant, additional investigation into the Spring 2022 semester could reveal more about the program's impact on student mental wellness.

Subjects: Interdisciplinary Research, Social and Behavioral Sciences

Investigating the Relationship Between Subjective Authenticity and Engagement With Political Social Media

Danniell Hale

Faculty Advisor: Matthew Vess, Ph.D.

The purpose of this study was to investigate whether subjective authenticity predicts political engagement on social media. According to Kernis & Goldman (2016), subjective authenticity reflects

people's feelings of knowing and expressing their true selves (Rivera et al., 2019). Research illustrates that subjective authenticity is strongly linked to well-being (Rivera et. al., in 2019). According to Rivera et al. (2019), people may be motivated to experience authenticity because authenticity is connected to their overall well-being. By that logic, people should be motivated to engage in actions that feel authentic to them. We thus hypothesized that viewing political social media engagement as authentic will positively predict more engagement. This research is important because it can identify a factor (i.e.,. authenticity) that predicts how much an individual engages in political or civic issues on social media. Social media is an unexplored realm as it relates to civic engagement and motivation. PEW research in 2022 found that 38% of people use social media for the purpose of engaging with political or social issues. Additionally, according to Mitchell et al., 48% of people between the ages of eighteen and twenty-four get their political news consumption from social media. Online participation can be viewed as an act of civic engagement, which is important in democratic societies.

Subjects: Science (STEM), Social and Behavioral Sciences

Investigation into the Lysis Inhibition Phenomenon of Bacteriophage N4

Teresa Sullivan

Faculty Advisor: Ryland Young, Ph.D.

Antibiotic resistance has become a crisis in which bacteria develop resistance to the prescribed antibiotics designed to kill them. This creates bacterial superbugs that can withstand antibiotics previously able to kill them, thereby making the infection difficult to cure. Phage therapy has become an option to kill bacterial infections without developing resistance since bacteriophages are bacterial viruses that kill bacterial cells. Once the bacteriophage attaches to its target cell, it ejects its DNA and uses cellular resources to replicate its own DNA. Once it replicates and assembles progeny, three specific phage-encoded proteins known as holins, endolysins and spanins carry out lysis. Each protein overcomes a specific layer of the host cell's membrane until eventually lysis is achieved in which the cell bursts and releases the phage progeny to hunt for new hosts. Most bacteriophage begin lysing cells at around 60 minutes post-infection. However, a phenomenon known as lysis inhibition, or LIN, prevents lysis in certain phage infections for up to 3 hours, causing an excess of 10-100 times more progeny to accumulate within the host cell. LIN is a defining characteristic of bacteriophage N4, but the cellular mechanism behind LIN is unknown. The purpose of this study is to identify the molecular causes of LIN. Discovering the mechanism of LIN may allow us to harness the ability to produce high titers of phage needed for therapy. In this study, wild type N4 was subjected to screening for spontaneous mutants causing the loss of LIN, or rapid lysers. Mutations in the lysis genes and noncoding genomic regions within the genome pointed to key genes involved in LIN. A cluster of mutations were found in one lysis gene, and from this, we have developed a model in which LIN regulation occurs via phosphorelay signaling. We anticipate that studying LIN will inform strategies for increasing phage production processes needed for successful phage therapy.

Subjects: Science (STEM)

Investigation of Homogeneous Degradation in Shape Memory Polyurethane Foams used in Embolic Applications

Thomas Cheung

Faculty Advisor: Duncan Maitland, Ph.D.

Shape Memory Polymers (SMPs) are a type of smart material that has the ability to transition from a deformed shape back to a preset shape when prompted by a stimulus, such as temperature change. SMPs have been used in a broad range of medical applications, such as blood vessel occlusion and aneurysm filling. The SMPs can be crimped to a compact, maneuverable secondary conformation for ease of placement, then actuated using the ambient body temperature and surrounding blood to expand back into its primary shape to fill a vascular region. Two types of SMPs are currently FDA approved biomedical devices and have been characterized via both *in vivo* and *in vitro* testing. However, because tissue grows throughout the SMP after *in vivo* implantation, it is often difficult to accurately measure the amount of degradation of these SMPs. By measuring mass loss gravimetrically through *in vitro* studies and correlating them with microscope and histological imaging at key degradation time points, we can help bridge the gap between the *in vivo* histological imaging of the degradation and the quantitative mass loss measured gravimetrically. This will also set the groundwork to create a calibration curve to quantify the amount of degradation seen *in vivo*.

Subjects: Engineering (STEM), Science (STEM)

Investigations of the Blow Fly Lucilia eximia (Wiedemann) (Diptera: Calliphoridae) for Use in Forensic Entomology: Nutrition Impacts Longevity and Temperature Impacts Development

Steven Graham

Faculty Advisor: Jeffery K. Tomberlin, Ph.D.

Lucilia eximia (Wiedemann) (Diptera: Calliphoridae) is a blow fly species native to the Neotropical region and southern North America. Lucilia eximia colonizes deceased or living vertebrates, including humans. Little is known about the biology and ecological impact of L. eximia compared to other blow flies, which inhibits their use in medicine and forensics in the United States. The authors have conducted two separate investigations on the longevity and development of L. eximia to help close this knowledge gap. Adult L. eximia survived on average 58.41 d when provided food and water, and 1.61 d when deprived of these resources. Maximum longevity was 118 d when food and water were provided and 2 d when it was not. Development of L. eximia was examined at constant temperatures of 25°C, 32°C, and 37°C. Egg, 1st instar, and 2nd instar life stages were completed quickest at 32°C. 3rd instars left the food source an average of 6.3 h faster at 37°C than 32°C. Hotter treatments resulted in more rapid development but increased mortality. When held at 37°C, only one individual pupated and no adults were observed. These works expand the knowledge of L. eximia, a previously understudied species in North America. The immature development and adult longevity of L. eximia reveal their expected interaction period with carrion resources. Understanding the development of L. eximia in medically useful life stages informs their practicality as a therapeutic. These investigations enable forensic entomologists in the Southern U.S. to use L. eximia for time of colonization estimates in casework for the first time.

Subjects: Science (STEM)

Isolation and Identification of Bacteriophages in Aedes egypti Mosquito Microbiome Samples

Charles Lee

Faculty Advisors: Gabriel Hamer, Ph.D., Catherine Busch-Silkwood, Ph.D. and Negin Mirhosseini, Ph.D.

The yellow fever mosquito (*Aedes aegypti*) is a globally important vector of viruses such as dengue, Zika, and Chikungunya. Despite control programs aimed at reducing the vector mosquito population, these *Aedes*-borne viruses continue to result in a large public health burden. In recent decades, the study of the *Ae. aegypti* microbiome has yielded several potential avenues of novel mosquito control approaches, due to the impact of microbe modulatory effects on vector competence, on the ability of a vector to transmit a pathogen, or on population fitness. Given that the microbiome is primarily composed of bacteria, it is possible that the same communities of bacteria that influence *Ae. aegypti* biology can be controlled by bacteriophages – viruses that prey on bacteria. This investigation focuses on the isolation and identification of bacteriophages in laboratory-reared *Ae. aegypti* microbiome samples. To accomplish the research goal, the project was separated into two distinct phases: 1) isolation of the bacteriophage and 2) identification of the bacteriophage. Phase 1 was further separated into two phases: 1A) isolation and identification of suitable hosts and 1B) direct isolation of bacteriophages. Completion of Phase 1 revealed that bacteriophages are found in the mosquito microbiome. Phase 2 is currently underway. A major goal of this research is to lay the groundwork to advance the utility of bacteriophage-mediated arbovirus disease control.

Subjects: Health and Medicine (STEM), Interdisciplinary Research, Science (STEM)

Kangaroos Vote, Joeys Vote: The Effect of Peer Influence on Undergraduate Voter Turnout for State and Local Elections

Katrina Leslie and Jessica Duty

Faculty Advisors: Kristy Pathakis, Ph.D. and Sarah Fulton, Ph.D.

In recent decades, the youth voter turnout on average has shown national declines in the United States. Many reasons for this are tied to a lack of understanding of the voting process, feelings of being uninformed, and political disinterest. The field of political science has been greatly interested in the voting behaviors of college-aged students due to this infrequent participation, however, most studies focus their scope upon national or state elections. Our research focuses on local elections to see how peers can influence traditionally less publicized and attended elections. We discussed with around 35% of one professor's students at a large Texas public institution the specific ballot items on the local election ballot using an in-person, peer-led presentation. Examples of how those items could directly impact their daily lives were also presented. Each group (control and treatment) completed the same survey regarding their collegiate involvement, family voting habits, as well as political preferences, and other categories of interest prior to the presentation. After the treatment and the election, students completed a second survey describing their election day actions. Our results anticipate to demonstrate a lack of impact that a single peer-led presentation has on college-aged voter turnout. With the initial analysis, the presentation did not sway students to register or vote. If we do find, however, that our full analysis demonstrates an increase in students voting, then this could be repeated on a larger scale to see if the same effect exists with larger samples. While the practice of internal efficacy likely did not greatly show its impact, the fact that some students voted who potentially would not have voted is still a success for democracy.

Subjects: Social and Behavioral Sciences

Keep Austin Safe: A Study of Mutual Aid Organizing during the February 2021 Winter Crisis in Austin Texas

Jessica Bomar

Faculty Advisors: Shannon Van Zandt, Ph.D. and Alicia Cooperman, Ph.D.

During the COVID-19 pandemic, a resurgence of mutual aid networks has provided communal funds and resource aid to local community members impacted by the coronavirus and climate disasters that have occurred during the pandemic, such as during the wildfire outbreak in the Pacific Northwest in 2020, as well as the February winter storm in Texas in 2021. This thesis investigates how mutual aid organizations in Austin Texas during the February winter storm and electric grid crisis adapted to unforeseen weather crisis that demanded aid resources and rapid organizing of distribution in almost unprecedented weather circumstances and a public health crisis. I will investigate if and how mutual aid organizations applied an underlying theory of governance founded on principles of transformative and racial justice to their aid outreach and distribution, as well as if these unprecedented circumstances posed a challenge to their structural approach to aid or undermined a general theory of justice and governance. This will be done by surveying mutual aid organizers directly involved in the Austin area during the storm with questions concerning if their organization adhered to general governance and justice principles in their aid practices, as well as by examining demographic data of aid recipients, if aid organizers are willing to share this information.

Subjects: Social and Behavioral Sciences

La Mission Liberatrice: Reframing the Algerian Media Censorship in the 21st Century

Myranda Campanella

Faculty Advisors: Dinah Hannaford, Ph.D. and Jocelyn Frelier, Ph.D.

On June 13, 2021, the Algerian Ministry of Communication revoked the media accreditation of the French television news channel France 24 in Algeria. This was during a period of popular protest led by the pro-democracy Hirak party, on which France 24 has been reporting heavily. While the Ministry claims the move was due to "the clear and repeated hostility of [France 24 toward Algeria] and its institutions, its lack of respect for the rules of professional ethics, and its practice of media disinformation and manipulation," France 24 issued a statement the same day confirming they were surprised by the action because of the channel's "transparent" coverage of all nations, including Algeria. Western-tied academics, media, and policymakers have viewed the revocation of France 24's media accreditation as anti-democratic in nature. For example, Khaled Drareni, a correspondent for the French-based Reporters Without Borders, told Voice of America, "In the same way that the [Algerian] government controls or tries to control the Algerian press, it also tries to control the foreign press," (Scott). I challenge the established view among Western academics and policymakers that media censorship in postcolonial Algeria, as Hafid Gafaïti argues, is simply an undemocratic action associated with control and a denial of basic human rights (Gafaïti 60). This specific decree was announced one day after legislative elections were held in Algeria and during a period of "mounting official pressure against the Hirak and a string of arrests of journalists and opposition figures," (France 24). However, I go beyond the lack of democratic identity to argue there are historical, political, and psychological impacts of French colonialism which together explain Algeria's decision to censor media and reclaim its own identity.

Subjects: Arts and Humanities

Lane Detection using Computer Vision and Machine Learning for Self-Driving Cars

Radhika Soni

Faculty Advisor: Dezhen Song, Ph.D.

Self-Driving Cars are not only a reality today but a glimpse into how advanced and complex technology is going to be in the next century. The best and the brightest have been brought together by industry and academia around the world in this race to develop the best Autonomous vehicles possible. There's one important question that remains a topic of debate, which techniques should one use, some researchers believe that traditional computer vision approaches are the answer, while several others have been utilizing deep learning-based approaches.

With this research, we compare which of these methods proves to be better in the case of lane detection, one of the most fundamental aspects of self-driving cars. The paper builds on previous research done in comparing the two approaches for various fields lists out the pros and cons of both approaches. The readers would have an in-depth understanding of the state-of-the-art techniques utilized for lane detection, giving them the ability to make an unbiased choice for their specific use case.

Subjects: Engineering (STEM), Technology (STEM)

Layer by Layer Surface Modification of Semipermeable Membrane for FMT Culture

Paul Kim

Faculty Advisor: Daniel Alge, Ph.D.

Fecal microbiota transplant serves as a method to treat various gastrointestinal disorders such as *Clostridium difficile* infection. Current methods of FMT directly administer a fecal extraction to supply the transplant material. However, the limitation in “good donors” for the transplantable material has hindered the refinement of necessary therapeutics. Due to these setbacks, studies shifted to a cultured transplant material approach that will allow the expansion of small, donated sample material to be cultured into the necessary fecal microbiota. Previously, the Alge lab has developed a method to create a simple, cost-effective, and scalable system to serve as an anaerobic bioreactor necessary in culturing the human gut microbiota. We hypothesize that by producing the necessary mucosal microenvironment that limits the over-population of certain species of bacteria, the diversity of the given culture will be increased. In efforts to increase the diversity of cultured microbiota, we addressed the use of a layer-by-layer assembly of alginate and gelatin. By applying these polymers onto a cellulose acetate dialysis membrane and crosslinking with a solution of glutaraldehyde, the bioreactor will be able to theoretically recreate both the mucosal and luminal phases. Overall, the improvement in reproduction of the human gut microenvironment will grant continuing insight into different applications of FMT to other gastrointestinal disorders.

Subjects: Engineering (STEM)

Light Produces Calcium Waves in Nature

Sofia Patino Hernandez

Faculty Advisor: Lawrence R. Griffing, Ph.D.

Calcium waves that arise from high intensity 405nm blue light photostimulation in *Arabidopsis thaliana* have been observed and studied in the Griffing Laboratory to identify photoreceptors and signaling significance. This project attempts to understand when and if this high-intensity 405nm light occurs in nature by analyzing the parameters that lead to high-intensity light in real-life conditions. Our model is that the light not only has to be of a specific wavelength and photon dose, but it also needs to shine on a specific subcellular region, the ER-chloroplast nexus, to get direct stimulation and produce the calcium wave. This research measures photon dose and wavelength required for photostimulation with a microscope-based spectrometer and power meter and whether dewdrops or raindrops might focus the light to a subcellular location. It also explores the varied factors that may affect the interaction of light with plant cells to create the photostimulation effect. Experiments will analyze the threshold at which photostimulation triggers signaling and correlate these experiments to how sunlight could also trigger signaling in real-life conditions. Other experiments explore the effect of a circadian rhythm in the respective calcium wave. Results from the literature search show a large effect on plant interaction with sunlight but further experiments must be conducted to focus on the effect of specific photon dose and optical wavelength on the calcium waves.

Subjects: Science (STEM)

Looking for QCD Phase Transitions in Mini-Bangs

Ian Matthews

Faculty Advisor: Ralf Rapp, Ph.D.

In Ultra Relativistic High Energy Particle Collisions, a state of matter known as Quark Gluon Plasma is formed. This phase of matter is extremely short-lived and not much is known of it behavior. In my research, I have studied the transition of this plasma into Hadronic Matter, looking for a first order phase transition. In this presentation, I share my discoveries that lowering the acceleration of the expansion of this matter increases the lifetime of the overall system. I also discuss how introducing a first order phase transition will decrease the acceleration of the system. Through this, I am will be able to describe what to expect experimentally if there is a first order phase transition taking place.

Subjects: Science (STEM)

Machine Learning Based Dynamic Voltage and Frequincy Scaling Performance Error Detection

John Muschinske

Faculty Advisor: Jiang Hu, Ph.D.

Modern devices are more and more optimized for speed and power efficiency. A system that regulates these parameters is Dynamic Voltage and Frequency Scaling (DVFS). Generally, all bugs or errors in a microarchitecture fall under two categories: performance and logical. These errors can apply to any component of the microarchitecture. A performance error is an error that results not in a logically incorrect output of a system, but a slowdown in the production of that output. Most broadly, errors related to DVFS would be not increasing voltage and frequency leading to slower execution in real time, or the inverse (increasing voltage and frequency) leading to wasteful power consumption and chip degradation. The first slows down the machine, and the second decreases

expected battery time. Using machine learning to analyze data extracted from gem5 to detect these errors is the purpose of this paper. To implement these errors, DVFS is forced in gem5 to demonstrate the poor behaviors, underamping, overamping, and overstability. In this case overstability refers to the case where the voltage frequency states (VFS) of the DVFS system are either hesitant to change, over prefer proximal VFS, or do not change VFS when the DVFS system should. Then transform this output into datamaps/heatmaps and train the machine learning image classification model from there.

Subjects: Engineering (STEM)

Machine Learning Based Monte Carlo Simulation of Protein Folding

Curran Watson

Faculty Advisor: Daniel Tabor, Ph.D.

A deeper understanding of protein folding would not only shed light on an important area of biology, but would also give insight into many dilatating diseases that result due to the incorrect folding of proteins. It is thus advantageous to further investigate how protein's fold. The primary tool to do this is through the use of simulations. Protein folding, however occurs on a time frame that is difficult to model using conventional means of simulation such as molecular dynamics simulations. Instead, new methods must be used to reduce the computational complexity of the problem and allow solutions to be discovered in a timely manner. Monte Carlo simulations are one viable solution that produce the same thermodynamic information as molecular dynamics simulations but in a faction of the time. In order to increase the accuracy of the Monte Carlo simulation, an artificial neural network, referred to as a variational auto-encoder, was trained on structural snap shots from an MD simulation of the small protein Huntington protein. This trained neural network was then leveraged in a Monte Carlo simulation to predict the possible paths of unfolding and folding in the conformational space of the protein.

Subjects: Science (STEM)

Maker Education: Language Status

Lauren Absher

Faculty Advisor: Rebecca Schlegel, Ph.D.

There is a growing trend in education called the "Maker Movement". This movement aims to allow children to utilize hands-on activities using things like 3D printing, coding, and building circuits in order to increase students' interest in STEM and their self-efficacy. While research has been done that shows positive effects of maker programs on self-efficacy, possible selves, and identity with STEM subjects and careers, most research focuses on the effects of the maker programs on the general population. Little research focuses on the effects of maker programs on students with low English proficiency, a group that is underrepresented in STEM careers, as compared to their fluent English speaking peers. This study aims to investigate language status as a moderator for the effects of maker programs, specifically, the effect of maker programs on self-efficacy in regards to STEM subjects and STEM career interest. This study was conducted with a small group of third and fourth grade students at a school in a low socioeconomic status area with a large portion of native Spanish speaking students. The findings are presented and the results and implications are discussed.

Subjects: Social and Behavioral Sciences

Manifest: Concept Art, World Building, and Realism in Fictional Settings

Katherine Karolczak

Faculty Advisor: Samuel Woodfin, MFA

Fiction can serve as a reflection of real life, often taking inspiration from personal experiences or global events. Historical influences in creative works give viewers a way to grasp the inner workings of a world and place themselves more easily within it. For my research, I will showcase how visual realism is achieved in works of fiction. More specifically, I will explore the field of concept art, and how one utilizes realistic visuals in concept art to make their work more understandable. Not only is this vital in pre-production and the field of concept art as a whole, research into this topic is necessary to better understand how history and real-life experiences can impact our perception of art. In this way, utilizing the ties between history and art can allow an artist to more genuinely connect to their audience. In the following sections, I will outline how imagery that evokes historical, architectural, cultural similarities connects a viewer better to artwork. In addition to documenting my findings, I will also produce a series of character designs inspired by Westerns and Lovecraftian novels to visually convey what I have learned. While the workflow and processes of concept art are not new in my field, the artwork that I will produce offers new and interesting ideas because of the scope of my theme. Tying the visual language between western history and horror through the use of historical visuals, clothing, as well as utilizing previously established western movie archetypes will make my art both believable and visually unique.

Subjects: Creative Works

Measure Ideation with Sketch Data

Yi Hong Anthony Teo

Faculty Advisors: Tracy Hammond, Ph.D. and Paul Taele, Ph.D.

Sketching is an important medium of communication used in a range of disciplines. In technical fields, sketching is used often to communicate ideas while collaborating in the design and ideation process. Previous studies have investigated metrics to improve sketching ability and ways to evaluate the quality of ideas generated through these processes. However, less research has been done on measuring the collaboration process for sketches or ideation as a whole. The rise of digital prototyping platforms have allowed people to collaborate with less limitations. In order to collect the metrics to evaluate the collaboration process through sketching, an online platform has been developed to support the C-Sketch idea generation technique. Participants carry out C-Sketch asynchronously by iterating upon sketches from other participants based on a prompt. By combining previous work on sketching metrics and evaluation of ideas, these closely linked processes can improve collaborative design processes in industry. Sketching metrics collected from participants through the process can be analyzed to discover contributions of each individual to the sketch and the idea as a whole. This project aims to evaluate individual contribution to the idea generation process through common sketching metrics. With the results of the study, we propose the development of a feedback system to improve collaborative sketching in the idea generation context.

Subjects: Technology (STEM)

Medical Device to Continuously Monitor Core Body Temperature

Brittany Tran and Cody Carlisle

Faculty Advisor: Limei Tian, Ph.D.

A patient's core body temperature can be used to monitor their state of health and can even provide insight to their metabolic functioning. However, accurate measurements of the core temperature are currently conducted through invasive methods, limited to operating rooms, or have high ranges on inaccuracy. Therefore, the question being researched is if a method or device can be used to non-invasively and accurately measure a patient's core body temperature. The 3M SpotOn device is one current solution to the addressed problem. It consists of disposable patches that can be applied to the forehead and a monitoring system to output the measured temperature. However, the patches in the device requires active heating from a power source and have been shown to have bandwidth limiters that could result in inaccurate measurements. As a result, the research project would consist of creating a new patch consisting of a primary cell battery that can last up to 4 days and commercial off-the-shelf materials with ideal thermal characteristics. To test the patches, a test system was created to determine the power loss of the system in order to calculate the fudge factor needed to output accurate core body temperature. It would be expected that the project would result in the assembly and characterization of 15 patches that can be approved for FCC class II certification and used as a reference design for other temperature sensing and monitoring solutions.

Subjects: Engineering (STEM), Health and Medicine (STEM)

Memory-Efficient Multi-Threaded Streaming Partitioning Algorithm

Alex Labbane

Faculty Advisor: Dmitri Loguinov, Ph.D.

Due to the growth of the modern Internet, data analytics, and cluster computing, massive amounts of data are frequently being generated and need to be processed. In many common data processing applications (e.g., sorting), a set of input keys needs to be partitioned into buckets based on their values. Since key partitioning is an application where data can be processed sequentially (i.e., via streaming), one such programming platform we can use to solve this problem is Vortex. Vortex creates the illusion of an infinite buffer by generating controlled memory access violations that are handled transparently. The buffer can be accessed with a single C/C++ pointer, making Vortex both extremely fast and easy to use.

Efficient parallelization of a key partitioning algorithm is required to take advantage of multi-core processors, which are now found even in low-end consumer hardware. With this in mind, we propose a high-performance, memory-efficient multi-threaded key partitioning algorithm, which makes use of multiple Vortex streams to allow for concurrent, in-place partitioning of keys by multiple threads in a single pass over the input data. The resulting algorithm is able to nearly saturate the memory bandwidth of modern Intel Coffee Lake systems and can be applied to develop high-performance, in-place, multi-threaded streaming sorts that are capable of utilizing the multiple processing cores available in modern computers.

Subjects: Technology (STEM)

Monte Carlo Denoising Using Implicit Neural Representations

Jonah Taylor

Faculty Advisor: Nima Kalantari, Ph.D.

Monte Carlo path tracing is a popular 3D rendering technique in computer graphics, but it often requires a costly tradeoff between the amount of noise in the image and computation time. Therefore, it is useful to attempt to "smooth out" a noisy image by either constructing new data between the samples or applying filters to the image. This work investigates the feasibility of training a neural network to implicitly represent the radiance of a fixed-viewpoint scene as a continuous function. The neural network is implemented using a multilayer perceptron network and trained on a sparsely sampled image that is generated by an offline Monte Carlo renderer. This training data uses the (x, y) coordinate of each sample on the image plane as inputs, and the RGB color of the sample as outputs. Additionally, the network accepts the surface normal, depth, and albedo of the first ray intersection as extra inputs alongside the pixel coordinates. These extra input dimensions improve the quality of the implicit representation by helping the network account for changes in depth, normal, and diffuse color. Once the network is trained on the sparsely sampled scene, it can be densely sampled many times per pixel to create the final denoised image. Early results of this work show that the network can quickly learn and denoise images in scenes with soft lighting and glossy reflections, and it can easily handle discontinuities in depth, normal, and diffuse color with just a small amount of training.

Subjects: Technology (STEM)

Morphological Trends in Experimental and Simulated Populations of Hybrid Swordtails

Max Chin

Faculty Advisors: Gil Rosenthal, Ph.D. and Heath Blackmon, Ph.D.

Naturally hybridizing species represent important study systems in evolutionary biology, providing insight into the mechanisms that drive reproductive isolation and speciation. One such system involves the swordtails *Xiphophorus malinche* and *X. birchmanni*, which have formed several replicated hybrid zones oriented around elevational gradients in the drainages of the Rio Calnali in eastern Mexico. As such, this system presents a unique opportunity to study the relationship between natural and sexual selection in guiding hybrid evolution. However, these natural populations are characterized by several generations of natural and sexual selection. To gain a better understanding of how early generation hybrids morphologically evolve across different ecological environments over time, this project monitored and simulated replicated experimental early generation hybrid populations along an elevational gradient, collecting and analyzing morphological data to compare against trait values simulated under several theoretical scenarios. Simulations were designed to accurately mirror up to date knowledge on the *Xiphophorus* genome, including several recently published QTLs associated with traits of interest. Informed by the life history of parental species and hybrids, a variety of natural and sexual selection functions were implemented. Simulated datasets were tested for significant effects of time and elevation on phenotype. Simulations intended to replicate Fisherian runaway selection demonstrate that such processes are reinforced when polygenic preference and sexually selected traits are paired with traits under active ecological selection. Our overall results suggest that strong natural selection has the potential to play a key role in driving differentiation in these hybrid populations.

Subjects: Science (STEM)

Mutation in SMα-actin Induces Changes in Vascular Smooth Muscle Cell Morphology

Robert "Jack" Zamen

Faculty Advisor: Andreea Trache, Ph.D.

Thoracic aortic aneurysm is commonly found in patients with ACTA2 mutations which encodes for smooth muscle α-actin (SMα-actin), the predominant contractile protein in vascular smooth muscle (VSM) cells. These mutations are associated with impaired VSM cell function in the aorta. This study investigates the relationship between cell adhesion and actin architecture in VSM cells isolated from aorta of mice presenting $Acta2^{R149C/+}$ mutation and wild-type controls plated on fibronectin extracellular matrix proteins. To investigate changes in integrin recruitment at cell matrix adhesions, cells were immunofluorescently labeled for integrins α5 and β1 and further imaged by TIRF microscopy. Also, cytoskeletal architecture was determined from confocal imaging of the same cells labelled for SMα-actin and smooth muscle γ-actin (SMγ-actin). Preliminary data showed that both integrin α5 and β1 recruitment at cell-matrix adhesions are decreased in mutant VSM cells when compared to wild-type VSM cells. Quantification of protein fluorescence measurements of VSM cells from $Acta2^{R149C/+}$ mice showed a downregulation in SMα-actin that was compensated by an upregulation of SMγ-actin in comparison to wild-type mice. These results suggest that the downregulation of SMα-actin leads to reduced VSM cell contractility, while the upregulation in SMγ-actin may lead to increased VSM cell stiffness. In addition, decreased integrin recruitment at cell matrix adhesions further reduces the ability of mutant cells to anchor within the extracellular matrix. Collectively, the results suggest that $Acta^{R149C/+}$ VSM cells present reduced contractility and interaction with the extracellular matrix, which are potential causative factors of thoracic aortic aneurysm.

Subjects: Engineering (STEM), Health and Medicine (STEM)

Network Vortex

Eta Gluck

Faculty Advisor: Dmitri Loguinov, Ph.D.

Explosive growth of the Internet, cluster computing, and storage technology has led to generation of enormous volumes of information and the need for scalable data computing. One of the central frameworks for such analysis is MapReduce, which is a programming platform for processing streaming data in external/distributed memory. Despite a significant public effort, open-source implementations of MapReduce (e.g., Hadoop, Spark) are complicated, bulky, and inefficient. In an effort to overcome this problem, we employ and expand upon a recent a C/C++ programming abstraction called Vortex that offers a simple interface to the user, zero-copy operation, low RAM consumption, and high data throughput.

In particular, this research examines algorithms and techniques for enabling Vortex operation over the network, including both TCP/IP sockets and data-link RDMA (e.g., InfiniBand) interfaces. We developed a new producer-consumer memory stream abstraction presented as a Vortex stream split across two hosts, travelling through a hidden network communication layer to provide the illusion of writing a continuous stream of data directly into a window of memory on a remote machine, thereby enabling the creation of high-performance networking code and size-agnostic data transport

written as simply as an in-memory copy operation, overcoming complications normally inherent in the discrete nature of network packet transfer.

Subjects: Technology (STEM)

Neural Network Approach to NFL Position Classification

Sithija Manage

Faculty Advisor: Sai Mang Pun, Ph.D.

With an ever-increasing captivation of the United States sports-viewing audience, the National Football League continues to produce some of the world's most capable, physical athletes. In this work, athletes' positions C, OG, OT, DE, and DT were categorized as on the line, while the remaining positions were categorized as not on the line. In this work, a predictive neural network is applied to classify 2,022 National Football League players into the two classifications using scouting combine data of height, weight, and 40-Yard dash time, outperforming the current standard logistic regression. The two measures utilized to compare the strength of the methods were total accuracy and area under ROC curve, with the neural network outperforming the logistic model in both. In terms of total accuracy, the neural network had an accuracy of 0.914 to the logistic model's 0.907, and in terms of area under ROC curve, the neural network had an area of 0.958 compared to the logistic model's 0.957. As a head-to-head iteration-wise comparison, the neural network had a winning Win-Loss-Tie ratio of 7-0-3 and 8-2-0 in the two measures respectively. Thus, this work demonstrates the predictive strength of neural networks in the case of sports position classification (at the cost of model interpretability).

Subjects: Mathematics (STEM), Science (STEM)

Neurally Integrated Ankle-Foot Orthosis for the Treatment of Foot Drop

Nate Martin

Faculty Advisor: Hangue Park, Ph.D.

The current state of orthotic treatment of foot drop and limited forward propulsion at ankle joint is constrained by the lack of responsive adaptability in passive orthosis devices. Orthosis and prosthesis technology has been trending towards active systems that better respond to patient needs and better approximate fully functional organic limbs. A critical facet of this adaptability is neural integration, by which the device is able to respond and actuate to triggers registered from the patient’s nervous system. While undoubtedly more costly than their passive counterparts, active orthosis systems can mirror and replicate the action of impaired or absent muscle groups. In the case of ankle foot orthosis devices this enables the creation of a more natural gait to improve patient recovery and quality of life outcomes. This paper will detail a novel design of active ankle foot orthosis implementing non-invasive neural control. This prototype device is capable of receiving and sending neural impulses from the peroneal and distal tibial nerve respectively. Received impulses control the actuation of the device to supplement the weak dorsiflexion inherent in foot drop and weak plantarflexion often observed after neurotraumas, by way of a series elastic linear actuator. This platform will enable better testing of foot drop and limited forward propulsion treatment. Additionally, testing and calibration of non-invasive nerve sensing in this prototype can be adapted into further devices. With the commonality of foot drop and limited forward propulsion as a neuromuscular condition, this device provides a powerful testing platform.

Subjects: Engineering (STEM), Health and Medicine (STEM)

Neuromodulatory Effects on Locomotion within Drosophila Melanogaster Larvae

Hannah Crowe

Faculty Advisor: Aref Zarin, Ph.D.

How motor neurons are regulated by neuromodulatory inputs is still poorly understood. Our hypothesis is that neuromodulatory inputs are one of the mechanisms underlying muscle coordination during larval locomotion. To test this, we silenced different neuromodulatory neurons using an inwardly rectifying potassium channel known as Kir2.1 as well we will eventually utilize optogenetics to silence neurons using a light-gated cation channel known as crimson. Following these perturbations, larval locomotion is examined using a whole animal behavioral analysis and tracking software known as WrmTrck. This software measures larval behaviors such as the length of the entire path traveled by the larvae and the average speed traveled. The results showed that when silencing dopaminergic and serotonergic neurons, larvae decreased in all parameters indicating that they act as a necessary neurotransmitter for muscle-induced locomotion. Octopamine silencing led to no observable changes in any parameters. As this research is ongoing more information will come to light and our observations will become clearer. The results of this research could help us further understand the Drosophila larval nervous system. In the future this understanding could aid in our understanding of how these same neuromodulators affect human motor movement and if they could potentially play a role in motor deficit-related neurodegenerative diseases.

Subjects: Health and Medicine (STEM), Science (STEM)

Nitrous Oxide Biogeochemistry and Air-Sea Flux in the Northern Gulf of Mexico

Hunter Adams

Faculty Advisor: Shari Yvon-Lewis, Ph.D.

Nitrous oxide (N_2O) is a potent greenhouse and ozone-depleting gas produced in the ocean and released into the atmosphere. N_2O is produced in areas of low oxygen such as hypoxic areas and oxygen minimum zones. The shelf region of the northern Gulf of Mexico (GOM) experiences seasonal coastal hypoxia, and the north-central GOM has an oxygen minimum layer at about a depth of 500 m. Water and air samples from the Northern Gulf of Mexico near the Deepwater Horizon oil spill site were collected and analyzed in the summers of 2015, 2019, and 2021. These results are used to better understand the potential change in the biogeochemistry of N_2O in the Gulf of Mexico in the face of climate change. Depth profiles and air-sea fluxes from this dataset are compared along the time series to examine the potential effects of climate change driven perturbations such as the formation of more intense eddies, changes in the strength of upwelling events, more intense storm events, and potential growth of the oxygen minimum layer on N_2O emission to the atmosphere in this region.

Subjects: Science (STEM)

Numerical Simulation of the Effect of Wave Characteristics on PTO of Point Absorber Wave Energy Converter

Abigail Rolen

Faculty Advisor: Mirjam Furth, Ph.D.

The ocean is currently an extremely large and under-developed source of renewable energy. The recent interest in the Blue Economy has led the scientific community to increase investigations in sustainable oceanic energy options, such as Point Wave Energy Converters (WEC). These devices harvest the wave energy using the excited oscillatory motion of the buoy, which is connected to a Power Take-Off system (PTO). During the last decades, the development of these devices has been boosted but they are still behind other renewable energy technologies. The Furthlab at Texas A$\&$M University has showed that the spheroid buoy shape with a low length to diameter ratio is a good candidate shape to extract wave energy, by testing different buoy shapes and aspect ratios at a non-linear Stokes-II wave generation. This paper is the next step in our research work and numerically investigates the effect of changing the wave characteristics, such as amplitude, frequency, and speed, on the power-generating ability of the spheroid buoy system. Three-dimensional Unsteady Reynolds-Averaged Navier-Stokes (URANS) simulations of the selected buoy were performed in OpenFOAM with the integration of a dynamic mesh module to handle the heave motion of the buoy. In addition, the PTO system was compensated with a forced oscillator mechanism of spring and damper. A comparison between the buoy's displacement and frequency responses, and power efficiency showed the optimal operating sea state to maximize energy output using the spheroid WEC. The results conclude that the best wave conditions to maximize the power extraction efficiency using a spheroid buoy with a diameter of 1 m and length of 0.5 m are wave length greater than 4 m, wave height less than 0.15 m, and wave speed between 0.07 and 0.12 m/s.

Subjects: Engineering (STEM)

Nurturing Scholarly Research of Future Physician-Investigators in Academic Medicine

Mikayla Monk

Faculty Advisor: Gloria M. Conover, Ph.D.

With the goal of becoming life-long physician investigators, medical students that participate in the Medical Scholar Research Pathway Program (MSRPP) observe, practice, and acquire scholarly research skills to impact patient care. MSRPP exposes medical students to scholarly research by designing personalized educational pathways that fit their career goals and research interests. MSRPP students are coached by the Program Director to select a research focus from a broad range of disciplines, spanning from biomedical to medical humanities, and are given tailored practical advice on how to approach a mentor and set achievable learning expectations.

The majority of MSRPP participants are traditional four-year medical students. Through 1:1 meeting, the Director assess the educational needs of students, forming a community of scholars in four dispersed geographical campuses across Texas. MSRPP's educational impact begins with the application and the mentor interview and culminates with a formal presentation in MSRPP's Launch Talk series, as well as participation in our annual Medical Research Colloquium (MRC) and Senior Research Showcase (SRS).

To assess MSRPP practices and reach, outcomes research was conducted by using interview data from all classes of MSRPP students. Furthermore, educational surveys were sent to all classes of

TAMU COM students at the start of three semesters (from 2020-2021) to evaluate student research interests and determine the baseline for research focus areas and long-term career goals that can be addressed by MSRPP. MSRPP and non-MSRPP students research outcomes will be compared alongside the survey data to further personalize skill set acquisition to prepare students for professional scholarly research endeavors. Our study revealed a strong desire for students to benefit from a formal structured scholarly research program, thereby preparing students for successful careers in medicine. Future directions will investigate the match rate of residency programs and the potential contribution of research in medical school.

Upon completion of MSRPP, students develop critical thinking skills and strong communication skills that equip them to engage in best medical practices and to establish collaborations with cross-disciplinary experts. Thereby, MSRPP students will be the next generation of physician investigators, well-positioned to prevent, diagnose, and treat chronic and infectious diseases.

Subjects: Health and Medicine (STEM)

Object Orientation Determination with Computer Vision in Mixed Reality

Braden DeVargas

Faculty Advisor: Stavros Kalafatis, Ph.D.

When assembling anything, using the correct part at each step is crucial; however, so is ensuring the correct placement of each item. Current mixed reality technology makes it possible to get the orientation and position of an “ideal” object. The more features an object has or the bigger it is makes it easier to identify and calculate its position and orientation. Obviously, a complex and feature-rich object won’t always be available or needed which is where this project comes in. The proposed system will be implemented on the HoloLens, a mixed and augmented reality headset, and will focus on determining the orientation of an object after it has been placed. Once the orientation of the object has been obtained, the system will be able to display holograms in the mixed reality environment to point to specific features on the object or to instruct the user to move it in a certain way. This is one of the fundamental pieces that will allow for complete assembly guidance from a system hence reducing the knowledge barrier required for complex assembly processes. The system discussed herein is being designed as a proof of concept since commercial technology is not advanced enough to allow for this system to function fully as intended. As the technology advances, this system can be expanded upon or updated accordingly.

Subjects: Engineering (STEM)

Of Monsters and Men

Amanda Roberts

Faculty Advisor: Jason Harris, Ph.D.

Folklore is a foundation upon which the greater human species experiences the phenomenon of storytelling. Still, due to the universal experiences of fear and hopelessness, there are dark sides to the hope-filled tales that permeate so much of the modern depictions of what these stories are supposed to represent. Exploring the themes present in many of the gruesome tales adapted to the silver screen, there is a connection to be found within fairytales and the cyclical nature of generational trauma; the overlap between the two is where horror gets to blossom.

Within the concepts explored in creature features like *Dracula*, *Teen Wolf*, or *Buffy the Vampire Slayer,* there are clear ties to stories like *The Young Slave Girl*, *Cinderella*, and *Jack and the Beanstalk*. By exploring these connections, the world opens up to see how a society's collective trauma can inadvertently change how their descendants learn about and explore the world around them. Learning about the origins of these beliefs and when they changed and why they were altered can lead to reimagining the worst parts of the human experience in a way that leads to healing and creativity. Part of this healing means examining why the monsters that used to hide in the shadows now find themselves as the object of young adult affections. The open embrace of the macabre and weird is nowhere near new. Still, its resurgence is one of the more intriguing consequences of the diffusion of information and ideas becoming easier.

Subjects: Creative Works

Open-Source Platforms for Serverless Computing

Kalista Bailey

Faculty Advisor: Dilma Da Silva, Ph.D.

Serverless computing is a promising development in the continued evolution and expansion of cloud computing. The first phase of the cloud was characterized by what may be referenced as "serverful" computing, while the emergence of serverless computing appears to mark the second phase. In contrast with its name, serverless computing does utilize servers in order to operate. However, unlike "serverful" computing, the servers are abstracted from the programmer's perspective, and the complexities of server maintenance are largely handled by the cloud provider. This shift in cloud computing allows developers to devote more of their time and resources to the details of their project rather than server upkeep. Serverless computing allows cloud computing projects to become a more accessible goal for a wider number of developers. There are currently many open-source serverless platforms available, offering distinct features and tools. These options include Apache OpenWhisk, Fission, IronFunctions, and OpenFaaS. OpenFaaS in particular offers a lightweight, portable option called faasd. This version allows the user to perform many of the same functions as OpenFaaS without depending on the user's knowledge of Kubernetes. Due to its relative simplicity, faasd acted as the particular focus of this research's investigation into open-source serverless platforms and how they operate with respect to scheduling the deployment of functions. A particular focus is paid to the issues that may prevent the further success of serverless computing development, namely inflated application run times, function drops, and inefficient allocations.

Subjects: Engineering (STEM)

Optical Metabolic Imaging of Tumors to Identify Tumor Heterogeneity via Cellular Metabolism and Reactive Oxygen Species

Raniyah Nathani

Faculty Advisor: Alexandra J. Walsh, Ph.D.

The growth and development of cancer cells differs from that of normal cells. Cancer cells exhibit increased metabolic activity and have increased production of highly reactive molecules called Reactive Oxygen Species (ROS), which serve as regulators of important signaling pathways and promote many aspects of tumor growth and progression. Factors such as environmental changes,

genetic mutations, and changes in the cellular and extracellular mechanical properties stimulate metabolic and functional heterogeneity to arise among tumor cells within the same patient. This has led to increased resistance to cancer treatments and greater difficulty in predicting how a patient's cancer will progress. To best address the relationship between cellular metabolism and tumor heterogeneity, optical imaging microscopy is employed to detect fluorescence signals of a ROS label and NADH, an important molecule in the process of cellular energy metabolism. A cyanide experiment is conducted to induce ROS in KRC cells, and ROS fluorescence assay is subsequently used to quantify ROS production. Fluorescence images of KRC cells before and after the cyanide experiment are acquired. Results demonstrate that both the optical redox ratio and ROS increased after the addition of cyanide compared to control cells without cyanide. While more experimental trials need to be conducted, current experimental outcomes relay the potential for using the relationship between NADH redox state and ROS levels to look at different phases of the cell metabolic cycle to quantify tumor heterogeneity in the future. This can help extend our understanding of the parallel between tumor treatment response and metabolically distinct tumor cell populations which is currently not well understood.

Subjects: Engineering (STEM), Health and Medicine (STEM), Science (STEM)

Perception of Wetness

Carla Bassil

Faculty Advisor: Cynthia Hipwell, Ph.D.

Human wetness perception plays a key role in maintaining homeostasis in both behavior and autonomic bodily responses to wet stimuli. While research has uncovered hygroreceptors (e.g. humidity receptors) in insect species, allowing them to sense moisture, few studies have been undertaken to find a similar receptor in humans. It is currently believed that humans lack such receptors in their skin but are rather able to perceive wetness through a cognitive association with external temperature and tactile stimuli. Previous studies have proven the importance of temperature in human wetness perception but have only gone so far as to take single temperature measurements of the skin or stimuli. Dry-cold stimuli and cooling the skin at the same rate as evaporative cooling have been shown to induce a strong sensation of wetness. While these findings are essential to understand factors influencing human wetness perception, a more intricate understanding of temperature distribution is needed to characterize the skin-object interface. This study aims to create a flexible temperature sensor array that can be attached to the tip of the finger. This array will function to monitor the spatial and temporal changes in temperature at the finger-object interface for dry vs. wet stimuli under different contact conditions. Based on previous studies, it is expected that increased wetness perception will positively correlate with lower temperature distributions and temperature cooling rates similar to that of evaporating moisture. Through this array, a mechanistic model can be created to characterize the individual role of thermal receptors in the perceptual illusion of wetness.

Subjects: Engineering (STEM), Interdisciplinary Research, Science (STEM)

Perfluorooctane Sulfonate and a Natural Phytoplankton Community: Pollutant Insight from the Base of the Aquatic Food Web.

Shaley Klumker

Faculty Advisor: Antonietta Quigg, Ph.D.

Perfluorinated alkylated substances (PFASs) are synthetic chemicals that have been ubiquitously used in industrial and commercial products which has resulted in their emission into environments globally. This is of great ecological concern as several chemicals in the group are toxic and persistent including perfluorooctane sulfonate (PFOS), which is the most abundant PFAS found in natural systems. PFOS is observed to negatively impact many aquatic species, however its impact on phytoplankton communities is relatively unknown. This research investigates the impact of PFOS on two natural phytoplankton communities collected from the Texas coast, one of high salinity (Gulf of Mexico coastal zone) and one of low salinity (Trinity River). 5-day bioassays were conducted with these communities in triplicates of increasing PFOS concentrations [0-30 (mg/L) ppb]. Photosynthetic efficiency, biomass, nutrients (NO3-, NO2-, urea, NH4+, HPO4-, SiO2), and stress response materials [transparent exopolymer particles (TEP) and extracellular polymeric substances (EPS)] were monitored during the study. We found that each ecosystem responds differently with increasing PFOS concentrations when assessing these parameters. Our results indicate that Gulf of Mexico phytoplankton communities are more vulnerable to PFOS toxicity compared to Trinity River communities. Determining the way PFOS impacts the base of the food web in different aquatic environments will aid in understanding the holistic effect of PFOS on aquatic ecosystems.

Subjects: Science (STEM)

Performance of Recurrent Neural Networks for Predicting ICU Mortality with Multi-Modal Models

Sehun Joo

Faculty Advisor: Bobak J. Mortazavi, Ph.D.

Electronic health records contain a plethora of additional data. Particularly unstructured notes, which include, but are not limited to surgical forms, discharge forms, examination sheets, and nurse diaries can contain vital information which could help predict various patient outcomes in the ICU. In this paper, I aim to create a model that uses natural language processing techniques to extract key features from each note, attempting to use deep learning structures that take advantage of the time-series nature of the notes. By creating and integrating this time-series of notes format, we will be able to see if having the data in a time series format can help to improve its prediction accuracy.

Subjects: Science (STEM)

Personalized Quantification of Facial Normality using Artificial Intelligence

Khalid Al-Emadi, Layan Al-Huneidi, Salma Aboelmagd, and Sara Mohamed

Faculty Advisors: Erchin Serpedin, Ph.D. and Mohammad Shaqfeh, Ph.D.

While congenital facial deformities are not rare, and surgeons typically perform operations to improve these deformities, currently the success of the operation can only be “measured” subjectively by the surgeon or their colleagues. No efficient objective way of comparing the work of surgeons or different surgery techniques exists presently, as any existing solutions are paired with downsides which reduce the efficiency of the programs. The aim of this research project is to develop an efficient application that can be used by plastic surgeons as an objective measurement tool for the success of an operation. The application would work by first scanning a face before and after an operation and providing the surgeon with a normality score of the face from 1 to 7, where 1

represents normal and 7 represents abnormal as well as a delta value which represents the change in the score. A high delta value would point to a high improvement in the normality of a face post-surgery, and a low delta value would indicate a small 2 improvement. The database of this application will be built by using images saved from a website that generates images of people who do not exist. Furthermore, a survey of images of children with varying levels of abnormalities was distributed. That is to obtain a dataset of how people would rate abnormalities, and using that dataset, the application can have a more human like approach to rating abnormalities.

Subjects: Engineering (STEM)

Phosphine-incorporated Metal-Organic-Framework for Palladium-Catalyzed Heck Coupling Reaction

Insha Shaikh and Fatma Ahmed

Faculty Advisor: Sherzod T. Madrahimov, Ph.D., Ma'moun Al-Rawashdeh, Ph.D.

The development of recyclable catalysts used in chemical applications is a vital field of research. The excessive use of harmful, non-recyclable materials in industrial processes contributes to environmental damage. The MOF (UiO-66) synthesized in this research has Zirconium-oxo clusters and BDC (terephthalic acid), which have the desirable characteristics required for application in catalysis. This work describes the application of MOF-immobilized Pd recyclable catalysts for Heck Coupling Reaction. We also established the generality of this reaction by running batch reactions on the substrate scope that included ten substituted aryl bromides with varying electronic properties. The catalyst synthesized, **UiO-66-PPh_2-Pd**, was also applied for the coupling reactions under microflow conditions. **UiO-66-PPh_2-Pd** was analyzed by several characterization techniques, including NMR, PXRD, TEM, and SEM. The optimum conditions for Heck Coupling Reactions using **UiO66-PPh_2-Pd** as the catalyst were explored for batch conditions. Using the optimized conditions, various bromo-substituted substrates (0.2 mmol) were reacted with 0.3 mmol styrene for which the highest yield of 93% was obtained for 4-bromobenzaldehyde. Substrates such as bromobenzene, 4-bromotoleune, 4-bromobenzonitrile, 4-bromoanisole, and 4-bromoaniline similarly had a high yield ranging from 90% to 92%. We demonstrated that the catalyst **UiO66-PPh2-Pd** could be recovered and reused for several catalytic runs. This research is vital to understanding the properties and applications of the synthesized MOF-catalyst and promoting the research in MOF-based heterogeneous catalysts. This work further sheds light on the potential of the recyclable, efficient, and robust catalyst for its use as drug carriers and other industrial applications.

Subjects: Engineering (STEM), Science (STEM)

Photocatalytic Hydrogen Generation from Seawater using High Performance Polymeric Materials

Ghalya Abdulla and Noora Al-Subaiei

Faculty Advisors: Mohammed Al-Hashimi, Ph.D. and Konstantinos Kakosimos, Ph.D.

Recently, there has been renewed interest in the use of solar energy as a resource to meet world's energy needs in an environmentally sustainable way. Hence, our research focuses on the generation of hydrogen from non-fresh water using the sun as an energy source. The aim of the research is to characterize, assess, and developed new research grade materials and commercial photo catalysts that are able to achieve sunlight-driven unassisted photo-splitting of water.

In this work, novel conjugated polymer nanoparticles were developed and characterized. The nanoparticles are composed of a donor-acceptor system where two acceptors (A1 and A2) were developed and tested, and different ratios of each donor-acceptor system were assessed. The use of platinum or molybdenum as co-catalysts was explored. Hydrogen evolution reactions with ascorbic acid as sacrificial reagent were performed using these materials and their performance was assessed.

The results show that the first system consisting of acceptor A1 and the donor (A1/D) produce more hydrogen than the (A2/D) system. Furthermore, the best ratio of donor: acceptor was determined to be 10:90 for the (A1/D) system. The use of platinum as a cocatalyst was shown to result in a better performance in terms of hydrogen production compared to the use of molybdenum. Furthermore, the results show that the use of nanoparticles suspended in solution results in a higher hydrogen evolution rate compared to the use of films. A hydrogen production of 2018 micromole per gram of catalyst per hour was achieved using the A1/D nanoparticle system with platinum.

Subjects: Engineering (STEM), Science (STEM), Other

Polyampholyte Hydrogels for Implantable Glucose Biosensors

Amelia Soltes

Faculty Advisor: Melissa A. Grunlan, Ph.D.

Continuous glucose monitors (CGMs) continuously monitor glucose levels and assist in the management of diabetes. A major barrier to long-term subcutaneous implantation of glucose biosensors is the foreign body reaction. Grunlan et al. have reported self-cleaning membranes based on thermoresponsive hydrogels that undergo cyclical swelling/deswelling to minimize cellular adhesion. In this work, charged semi-interpenetrating network (semi-IPN) hydrogel caps were developed with the goal to utilize electrostatic interactions to create adhesion between the caps and the negatively-charged self-cleaning membrane wall. Polyampholyte hydrogels feature monomers of opposite charges, which give the hydrogels unique properties. Polyampholyte semi-IPN hydrogels were prepared with several polyelectrolytes, wherein the uncrosslinked polyelectrolyte was contained in the network via entanglements and physical interactions. Polyampholyte hydrogels were fabricated with [2-(acryloyloxy)ethyl]trimethylammonium chloride (AETAC), a positively-charged monomer, and sodium 4-vinylbenzenesulfonate (NaSS), a negatively-charged monomer. Positively-charged poly(diallyldimethylammonium chloride) (PDADMAC) or negatively-charged poly(sodium 4-styrenesulfonate) (PNaSS) was added to the polyampholytes as a polyelectrolyte. Moreover, poly((3-acrylamidopropyl)trimethylammonium chloride) (PAPTAC) was synthesized as a positively-charged polyelectrolyte. To characterize their properties, water content and mechanical tests were performed. Results have shown that polyampholyte hydrogels with 1.0 wt. % of PAPTAC exhibit comparable compressive modulus, strength, and toughness to polyampholyte hydrogels with no polyelectrolyte. Adhesivity of polyampholyte hydrogels to the self-cleaning membrane is ongoing.

Subjects: Engineering (STEM)

Polysubstance Exposure to Ethanol and Cannabinoids Induces Synergistic Effects on Mouse Embryonic Neural Stem Cell Growth

Shruti Mavuri

Faculty Advisor: Rajesh Miranda, Ph.D.

During embryogenesis, neural precursor cells give rise to temporally and spatially distinct neural stem cells (NSCs) and progenitor cells. NSCs are multipotent cells that are able to self-renew and proliferate without limit. Studies have shown that ethanol influences NSC renewal and maturation. Little is known about cannabinoid effects. We studied the effects of drug exposure on NSC growth in vitro using non sex-segregated neurosphere cultures from the dorsal neuroepithelium of mice. Neurospheres were exposed to varying concentrations of nicotine, ethanol and/or cannabinoid or 5 days. The cells were then passaged to drug-free media for analysis using ImageJ, where area was measured. Our data show that the combined exposure group had significantly more growth than the single-drug and non-drug exposed groups on post exposure day 1. Furthermore, 2 weeks following drug exposure, only NSCs exposed to both cannabinoids and ethanol showed a significant difference from controls, and interestingly, in the opposite direction as the initial effect.

After gathering an idea of how drug exposure affects neurospheres, we were interested in analyzing how the development of neurospheres change when precursor cells are exposed to these substances. This time, neurospheres were split into single-cell precursor populations prior to exposure with identical protocols. In males, we saw no change in NSC size following exposure. In females, precursor cells exposed to cannabinoids produced much larger NSCs than the ethanol and co-exposure groups. All drug exposures resulted in the production of fewer NSCs than control. Our next steps include immunostaining and RNAsequencing of neural growth factors within exposed NSCs to identify underlying mechanisms contributing to growth deficits.

Subjects: Health and Medicine (STEM), Science (STEM)

Possible Mitigation of Global Cooling due to Supervolcanic Eruption via Intentional Release of Fluorinated Gasses

Nathanael Ribar

Faculty Advisor: YangYang Xu, Ph.D.

Supervolcanic eruptions are among the most powerful natural phenomena known to occur on Earth, ejecting over 1000 cubic kilometers of material in a single eruptive episode. Such events are very likely to have significant impacts on global climate, with reflection of solar radiation in the upper atmosphere driving global cooling at rates nearly an order of magnitude more severe than those caused by anthropogenic warming. Such strong cooling, even if only persisting for several years, would present immediate and drastic stress on biodiversity and food production, and thus is deemed a global catastrophic risk to civilization. Here we quantify the possibility of offsetting the supervolcanic cooling due to sunlight via the intentional release of certain greenhouse gases (GHGs). While well-known longer-lived compounds such as CO2 and CH4 have obvious limitations, certain sets of fluorinated gases (F-gases) could be manufactured and released – on the scale of multiple gigatons per year – to enhance atmospheric greenhouse effects and thus significantly offset supervolcanic cooling. Using a simple one-dimensional energy balance model constructed in Python – validated with observations and estimates of the climatological effects of past eruptions – various GHGs were tested to determine their capability to offset cooling by calculation of atmospheric forcing (W/m^2) and global average annual temperature anomalies (°C) given a mass emission. Oxygen and methane were ruled out due to long lifetimes and resulting unacceptable overheating on the decadal scale. A modified version of methane was used to narrow down chemical and radiative parameters, the result of which was a list of fluorinated compounds whose temperature residuals post-eruption were modeled and discussed in the context of geophysical, chemical, and

financial drawbacks. Various eruption scenarios (single-pulse eruptions, multi-pulse eruptions, and flood basalt events) were modeled with corresponding mitigation regimes modeled and scrutinized. Possible application to much longer-term cooling driven by orbital changes is also discussed, along with other cooling-driven risks such as thermonuclear conflict and cosmic impact events. Though caveats and drawbacks are numerous, any potential solution to a global catastrophic risk deserves careful and open-minded scrutiny for the sake of humanity's eventual longevity.

Subjects: Science (STEM)

Potassium and Ammonium Exchange in Sodalite and Cancrinite

Mackenzie Jeter

Faculty Advisor: Youjun Deng, Ph.D.

During this study, the sodium sites on the structures of Sodalite (SOD) and Cancrinite (CAN) were exchanged with potassium and ammonium under various conditions to generate a kinetic constant. SOD and CAN are two products formed during the Bayer process used in the alumina refinery. Their unique frameworks, which contain cages and channels, can serve, in fact, as a template to house a regular array of well-defined nanometer-size clusters with potential optic, electronic, and magnetic properties which can be applied to agronomic uses. Specifically, sodalite and cancrinite's highly negative charges allow cations to enter the cages and channels to balance the charge of the structural framework. This results in the retention of a large quantity of cations not even soil clay minerals are capable of. Previous studies have calculated the potential cation exchange capacity of these residues to be around 820 cmol/kg. By exchanging the Na+ sites in their structures with ions that are beneficial to plant growth and soil health, SOD and CAN have the capacity to be used in a productive way for agriculture. For this experiment, both potassium and ammonium were exchanged with SOD and CAN. The SOD and CAN samples consisted of 50 mg of mineral and 10 mL of either 0.5 M NH4Cl or 0.5M KCl. The experiments were performed under 15 different reaction times spanning from 5 minutes to 1 week. Each reaction time was completed under both room temperature (25 ° C) and 40 ° C. Once each reaction time had elapsed, the samples were centrifuged, and the supernatants were harvested for Na quantification via ICP. From the preliminary results, the maximum exchange rate for potassium and ammonium occurs for both SOD and CAN. However, the experiment is still ongoing, and the results are not complete.

Subjects: Science (STEM)

Probing Activity of AziB in Forming 2-Methylbenzoic Acid

Alejandra Rivera

Faculty Advisor: Coran Watanabe, Ph.D.

Discovered in *Streptomyces spp.,* azinomycin is a natural product with unique structural features that allow the crosslinking between purine bases in DNA. The effect of base crosslinking is cytotoxicity and antitumor activity, giving azinomycin the potential as a chemotherapeutic. The biosynthetic pathway of azinomycin includes a polyketide synthase (PKS) enzyme complex responsible for the formation of the 5-methylnaphthoate ring moiety. This moiety aids in the docking of azinomycin to DNA, and the enzyme complex to form 5-methylnaphthoic acid is composed of polyketide synthase AziB/AziG. Previously, the absence of AziG in an *in vitro* assay with PKS observed the production of 2-methylbenzoic acid. This truncated product was theorized to be

prompted by a shunt mechanism due to the disruption of AziG activity. However, a controlled *in vitro* assay of PKS AziB revealed the truncated product was formed by aldol reactions in no-enzyme controls, suspected to be due to extraction conditions. Changes were made to extract the i*n vitro* assay, but results were inconclusive to determine whether 2-methylbenzoic acid was formed due to the AziB predicted mechanism.

Subjects: Science (STEM)

Quality Assessment of Elasticity Images Obtained Using Different Ultrasound Systems

Samantha Morganti

Faculty Advisor: Raffaella Righetti, Ph.D.

Elastography is an ultrasonic imaging modality, which is useful in gaining new information about tissues and diagnosing diseases. Theoretical and simulation work has been done to determine how the parameters of an ultrasound system affect the quality of elasticity images but limited experimental validation has been performed so far. This study investigates the quality of elasticity images obtainable by using ultrasound systems with different specifications. Image quality is analyzed in terms of contrast-to-noise ratio, signal-to-noise ratio, and spatial resolution. These quality factors in elastography depend on mechanical parameters (such as applied strain and boundary conditions), acoustic parameters (such as transducer center frequency, bandwidth, etc.), and signal-processing parameters (such as window length and window separation for cross-correlation based strain estimation methods). Two ultrasound systems operating with different frequencies and bandwidths will be used, and the analysis will be carried out using theoretical and simulation software as well as experimental data. Theoretical and simulation results demonstrate that the system with higher center frequency and larger bandwidth produces elastographic images with higher quality. Experimentally, the attainable improvement is expected to be lower than the one predicted by theory and simulations. This study builds on prior theoretical research with experimental data to demonstrate that ultrasound systems with increased ultrasonic capabilities produce higher quality elasticity images. As these systems are used for the identification of elastographic markers in tissues, understanding their quality limitations using a systematic study will be useful to understand and interpret future pre-clinical and clinical data.

Subjects: Engineering (STEM)

Quantification of Genes That Encode for Antibiotic-Resistance in Soils

Denise Pedraza

Faculty Advisor: Itza Mendoza-Sanchez, Ph.D.

Antibiotic resistance has negative impacts since it decreases the effectiveness of antibiotics and they no longer stop an infection caused by bacteria. Antibiotics are introduced into an environment through animal waste and other sources, which give rise to antibiotic resistant bacteria strains.[1] Since many animals are treated with antibiotics, their environment will usually have contact with these antibiotics too. With a given exposure of antibiotics comes a resistance to them which is how the soil these animals interact with will contain antibiotic resistant genes. It has been observed that when the levels of antibiotics increase, the antibiotic-resistant bacteria and genes increase as well which leads to a greater risk of exposure to this bacteria when people work consistently with soils that are being treated with antibiotics.[2] Human contact with antibiotic-resistant bacteria in the

environment can lead to infection.[3] Soils contaminated with antibiotics have been recognized as a threat for those working in the agricultural sector. Although there has been some research in antibiotic resistant genes there are few studies on soils, especially those using quantitative polymerase chain reaction (qPCR) or even digital droplet polymerase chain reaction (ddPCR). We hypothesized that with a defined concentration of antibiotics introduced to the soil there will be an increase in the resistance genes observed throughout a period, which can be determined through the quantification of specific antibiotic-resistant genes (ARG) in soils. Our work will aid in the work being done in this field, since we will be able to report problems we encountered and how we decided to troubleshoot.

Subjects: Science (STEM)

Raman Spectroscopy Enables Highly Accurate Differentiation Between Young Male and Female Hemp Plants

Samantha Higgins

Faculty Advisor: Dmitry Kurouski, Ph.D.

Determination of hemp (Cannabis sativa) sexuality is an integral part of the hemp industry. Current methods of analysis can be costly and invasive. Genetic testing is most often required which involves sending leaf samples to a laboratory for results. Taking samples from new hemp plants can pose a risk due to the sensitivity of the young plants. Raman spectroscopy provides a way to accurately and non-invasively differentiate between young male and female hemp plants. A portable, hand-held Raman spectrometer was used as our instrument of analysis which does not disturb the plants in any way. Highly accurate and nonintrusive hemp differentiation is exceedingly important to hemp growers due to the preference for female hemp. Female hemp plants have a higher concentration of cannabinoids than male plants. Current efforts to minimize cross-pollination are not as effective as predetermining males or females. Our results show that mature male and female hemp can be distinguished with an accuracy of 94% and even more importantly, that young hemp plants can be differentiated with 90% accuracy. In conclusion, our findings will allow hemp growers to save valuable time and expenses. This discovery broadens the many applications of Raman spectroscopy and can expand the means by which plant sex determination is being conducted.

Subjects: Science (STEM)

Random Forest Based Prediction Module Deployment On FPGA

Duo Wang

Faculty Advisor: Jiang Hu, Ph.D.

Random forest algorithm has been used broadly in both the research field and in the industry due to its ability to tackle both categorical and numerical dataset. FPGAs also have the highest growing potential and is best combined with RF algorithm due to its low power consumption and parallelism support. Research have shown that a compact random forest algorithm is best executed through threading and pipelining, and a FPGA implementation shows the best results compared to GP-GPU and CPU implementations in the area. It was able to process each decision tree within the forest independently in parallel. My research is dedicated to replicate this result by benchmarking individual performance running the same RF prediction algorithm on different platforms. The HDL code running on the FPGA will be translated from the source C++ code through Vitis HLS to be

synthesized onto the FPGA board. The training data and the binary files will be processed beforehand for an equal competition for all platforms. I will be using various optimization techniques including loop unrolling and data-level parallelism to fully utilize the capabilities of FPGAs. With sufficient data and analysis, my result will show that FPGAs perform better compared to other platforms such as CPU or GP-GPU.

Subjects: Engineering (STEM)

Reconstructing the History of a Patagonian Peatland

Emily Rabel

Faculty Advisor: Julie Loisel, Ph. D.

Plant macrofossils in peatlands decay very slowly over time due to the high water saturation, low temperatures, and anoxia. Therefore, these ecosystems are an excellent way to study past climates and how they have affected the composition of these landscapes.

The Beef Penguin peatland in Patagonia has been carbon dated to be around 15,600 years old. This presents an opportunity to reconstruct the history of Earth's past climatic trends in this region. A research team collected a peat core from this Patagonian peatland that is 770 cm long. Plant macrofossil identification was done on samples of this core at 8 cm increments in order to determine when changes in vegetation occurred. Samples were also taken from places in the core where there appeared to be abrupt changes in vegetation in order to view the changes at a higher resolution.

Sphagnum spp. dominated the vegetation from the surface to about 158cm. Brown mosses were found from 300 cm to about 754 cm in depth, peaking between 630cm and 642cm. This is consistent with the formation of peatlands. From 158 cm to 610 cm in depth the samples contained high amounts of herbaceous plant matter.

These vegetation reconstructions can then be used to infer past temperature and precipitation regimes because we know which conditions are preferred by different plant communities based on modern-day observations across large landscapes. This information will allow the prediction of how projected climate change could influence the vegetation communities of these important ecosystems.

Subjects: Science (STEM)

Reducing Per- and Polyfluoroalkyl Substances in Breast Milk

Kaylyn Dinh

Faculty Advisor: Natalie Johnson, Ph.D.

Per- and polyfluoroalkyl substances (PFAS) are widespread environmental contaminants. PFAS can bioaccumulate and persist in the human body for years and have been associated with reproductive and developmental effects. Breastfeeding is one major route of PFAS exposure in infants as lactation is an excretion pathway. While breastfeeding provides ample nutrition, immune and developmental benefits for infants, lactational PFAS transfer represents a potential risk for infant immune development and possibly other long-term adverse effects. Currently, there are no existing filtration

techniques for removal of PFAS contaminants in breastmilk. The main objective of this study is to evaluate the ability of various binders, including activated carbon and clays, to sorb PFAS in breast milk. A secondary objective will be to examine if binding decreases toxicity using a bioassay employing *Hydra vulgaris*. Future studies will be extended to test if binders sorb any key vitamins or nutrients in the milk. In this case, we will need to select which nutrients to check for in by using a standard milk nutrient analysis and measure protein levels using analytical techniques. However, there are some challenges that may be encountered. Due to the physiochemical properties of PFAS compounds, this limits the resources and analytical methods that may be used. To overcome these challenges, we will combine several approaches for the analysis of PFAS in milk.

Subjects: Health and Medicine (STEM)

Regenerative Thermoelectric Cooling for Implantable Medical Devices

Samuel Patterson

Faculty Advisors: Aydin Karsilayan, Ph.D. and Jose Silva-Martinez, Ph.D.

Implantable Medical Devices (IMDs) are a category of medical devices that include pacemakers, implantable cardiac defibrillators, spinal cord stimulators, and many other devices. Many of these devices are battery-powered such as pacemakers which last an average of 7 years before needing to be replaced via surgery. This research focuses on re-chargeable IMD's such as spinal cord stimulators. Re-chargeable IMD's often require daily charging to operate which can be a burden on the patient. Shorter charge times are desired for improved usability. One significant limitation of these re-chargeable IMD's is that the charging current is reduced from optimal levels to mitigate heat buildup of the device. A high heat generation during charging is not acceptable due to FDA regulations that IMD's are bound by. This heat is primarily emitted from the charging battery-element within the IMD and can be harmful to human patients. Unfortunately, limiting the current throughput as a solution for the generated heat, results in a longer charging time that affects a patient's quality of life.

This paper serves to document the research performed on the integration of thermoelectric generators (TEGs) in such medical devices. It will present the thermal and electrical impacts that a TEG has on the charging times of IMD's. The TEG serves to harvest the heat energy that is normally wasted by the battery and convert it into electrical energy. The converted heat energy is expected to reduce temperature buildup and provide additional electrical charge to the IMD battery. This should allow for additional charge current to be safely introduced, further increasing the rate of charge. This research will explore how effective thermoelectric devices can be in reducing the charge time for these medical devices. Ultimately, this research aims to increase the quality of life for IMD patients by reducing charge times.

Subjects: Engineering (STEM)

Researching the Airborne Contaminants in a Chicken Coop

John Cate

Faculty Advisor: Maria King, Ph.D.

This study evaluates computer-aided design (CAD) to optimize the airflow in a ventilated chicken coop, possibly reducing the entrainment of potentially pathogenic bioaerosols (fungi, bacteria,

viruses, toxins) and ensure proper ventilation for the health of the birds. In addition, air property measurements and bioaerosol sampling tests will be repeated in the improved coop to validate the model and monitor the air quality. Most current research pertains to the commercial side of the poultry industry and not the residential, backyard poultry rearing that has exploded in popularity within the past few years. With the two industries becoming intertwined, due to biosecurity laws, the residential portion of the industry needs to adopt and promote proper safety protocols that will ensure the health of all poultry within the surrounding area. The model will be created based on air property measurements (temperature, relative humidity, air velocity) in a residential chicken coop and the as-built layout of the coop. To develop this model, SolidWorks Flow program will be utilized on a PC, using an environmental data logger and the software, HOBOware, to measure and analyze the ambient air properties for the airflow model. Based on the model, tests will be conducted in the hot-spot locations of the existing chicken coop where stagnant or turbulent air is present using environmental sampling with the wetted wall cyclone bioaerosol collectors to monitor air quality and determine if the chicken coop has adequate airflow to maintain sanitation. The bioaerosol samples will be collected for 20-minute periods at different locations in the chicken coop and processed in the laboratory by microbial and molecular methods, for viable and total bacteria count and microbiome composition.

Subjects: Engineering (STEM), Science (STEM)

Resource Management in Serverless Computing

Logan Keim

Faculty Advisor: Dilma Da Silva, Ph.D.

Serverless computing is a way in which users or companies can build and run applications and services without having to worry about servers. This is a great innovation because servers incur a large amount of overhead and can be very complex and difficult to work with. The serverless model also allows for on demand resource allocation, allowing for better scalability and cost reduction. Serverless computing is an amazing innovation but it does have some inherent trade-offs. Some of these include not being able to simultaneously have low latency, low cost, high throughput, and fine-grained access, not having control over specific states, losing some control over scheduling, sometimes significant latency increases, and some lost optimizations from servers. Overcoming these challenges highlights some of the tension between giving programmers control and allowing providers to optimize automatically. This research will discuss some of the challenges with serverless computing (specifically FaaS) as well as attempt to deal with one of these challenges. In order to demonstrate some of the challenges as well as be able to try and overcome some of these challenges, this paper will focus on faasd from OpenFaaS. This is a more lightweight variant of the open source serverless function framework OpenFaaS. Faasd was chosen over the normal OpenFaaS due to not have the higher complexity and cost of Kubernetes. In order to demonstrate these challenges in a proper environment all experimentation and benchmarking will be done in an AWS Lightsail instance running Ubuntu 20.04.3. This environment was chosen to use linux features as well as make the most of the benefits of faasd. This environment will be used to discuss the challenges of serverless computing in general as well as specifically the challenges of faasd. In addition to discussing the challenges this study will also attempt to improve upon the scheduler used in faasd in order to mitigate one of the issues with serverless computing.

Subjects: Engineering (STEM)

Revising Environment Maps in Real Time

Yashas Salankimatt

Faculty Advisor: Stavros Kalafatis, M.S.

When mapping indoor environments that have frequent changes in the environment, like whenever the state of doors is changed or if furniture has moved, existing robotic systems struggle since they most commonly build a static map of their surroundings that is not able to recognize its location whenever only a few things are changed in the surroundings. As robots continue to be used alongside humans, robots and robotic systems should be able to understand where in their environment they are without nearly as much previous knowledge and update their understanding of their surroundings as they explore. This research attempts to solve these problems and make a robot be able to localize itself in a previously known map and then dynamically update that map without the need for remapping the environment completely, providing itself the most up to date environment map for navigation purposes. This research yields a system that allows for the accurate revision of a previously generated ground truth environment map while being able to localize a robot with no previous knowledge of its location within the environment. This research also yields an implementation of this system on a physical robot with a LIDAR sensor, as well as a simulation of this system and a comparison of this method with other methods of localization and map revision of small, day-to-day changes to human indoor environments.

Subjects: Science (STEM)

Santarem Project: A 3D recreation of the Portuguese City

Raiyan Bhuiya

Faculty Advisor: Richard Furuta, Ph.D.

Santarem is a town in Portugal that contains centuries of rich history. The area was originally populated by the Lusitani, then followed by the Greeks, Romans, Visigoths, Moors, and finally the Portuguese Christians. The architecture and landscape evolved with the arrival of each new group. They built upon the existing buildings to adapt to the ideas and culture that they had brought along with them. This has resulted in key structures remaining but going through different stages of variations.

A lot of the history of the city has been documented but hasn't been published online. The purpose of this project is to design a three-dimensional recreation of the town which can be examined by anyone. Along with the models, physical documents will be linked to key interests to provide context and further background information. The aim is to have all this available on a website similar to Texas A&M's interactive website of their campus.

An open-sourced modeling software (Blender) will be used to create the accurate reconstructions of the buildings. The terrain will be created using the Shuttle Radar Topography Mission (SRTM) by NASA in order to have an accurate depiction of the town's landscape and elevation. Buildings will be modeled using pictures and drawings for the optimal recreation. The goal of this project is to be another form of preservation of Santarem's history. It will be available for the public to view and learn about Santarem.

Subjects: Arts and Humanities, Technology (STEM)

Scientific Machine Learning: An Approach to Cognitive Radars

Ty Buchanan

Faculty Advisor: Raktim Bhattacharya, Ph.D.

A cognitive radar is a theorized radar system based on the perception-action cycle of cognition that can sense the environment, learn through interactions within it, and then adapt the radar sensor to optimally satisfy the needs of a desired mission. Essential features of a cognitive radar that differentiate it from a classical radar is the active feedback loop between the receiver and transmitter, and the underlying learning algorithm that allows the system to improve with experience without human intervention. While research has been conducted to add cognition to radar systems by modifying and reconfiguring radar circuitry, few attempts have been made to develop a numerical method of obtaining solutions to Maxwell's Equations in air mobility problems. A cognitive radar system would need to possess this capability to improve real-time remote sensing while incorporating physical laws and constraints to guarantee a scientifically valid solution. By considering the specifications of this intelligent system, we seek to implement a form of machine learning, known as Scientific Machine Learning, to possibly deliver the set of described requirements for an intelligent radar system. This method of machine learning introduces scientific model constraints and physical laws to develop new methods for robust learning that prove to be useful in physical sciences and engineering applications. The aim of this research is to verify whether a solution for the physics-based requirements of a cognitive radar system can be realized through scientific machine learning.

Subjects: Engineering (STEM)

Sensor Selection for Multi-Agent Behavior Validation

Patrick Zhong

Faculty Advisor: Dylan Shell, Ph.D.

Current work on minimum sensor selection for validating itineraries poses the question of the optimal sensor placement for verification of whether an agent moves through an environment the way it said it would. The agent provides an itinerary, which represents a set of paths they could have taken through a facility composed of rooms. The goal then, is to use output from beam and occupancy sensors to determine whether the provided itinerary was followed by the agent, or if there are inconsistencies or contradictions between the itinerary and the sensor data. Specifically, what we are interested in is the minimum arrangement of sensors required in order to achieve this goal.

An integer linear programming approach has been explored in order to determine this minimum sensor selection. In our research, we built a boolean satisfiability formulation using the same underlying constraints, seeking performance benefits and lower runtime on larger problem sizes. In addition, we developed solutions for the multi-agent case where multiple agents each with their own itinerary move through the same building, and in the process created ways to combine world graphs and agent itineraries, as well as a new pruning approach to remove parts of the world graph that are unused for optimization purposes. The multi-agent validation problem also raised new concepts of time-stepping and how to handle different cases of when agents can loiter in rooms.

Subjects: Technology (STEM)

Sexual Harassment in the Workplace: A Look into Andrew Cuomo and Harvey Weinstein

Tanvi Deshpande

Faculty Advisor: Chaitanya Lakkimsetti, Ph.D.

News stations and social media have extensively covered the stories of Harvey Weinstein and Andrew Cuomo surrounding their sexual harassment allegations. Both Weinstein and Cuomo, one a corporate entity and another a government entity, are widely known across the nation for being accused of harassment. This paper focuses on each case to compare the charges against them and employer liability policy in a corporate versus a government setting. After reviewing both cases, the paper expands on New York's laws regarding sexual misconduct and how both men were tried under the same state's laws but had very different conclusions to their cases.

Subjects: Arts and Humanities

Simulating Shared Memory on Top of Message-Passing Distributed Systems for Poorly Behaved Systems

Emma Ziesmer

Faculty Advisor: Jennifer L. Welch, Ph.D.

Distributed computer systems are comprised of multiple processing nodes that communicate and coordinate by sending messages to each other. They are often used to handle tasks that are too large to be handled by a single processor. Some of these tasks can involve accessing and modifying a data object shared between all of the nodes. Algorithms have been developed in the past that allow these nodes to keep a local copy of the data object and coordinate modifications to the object so that the operations are guaranteed to be linearizable (appears to be sequential). This paper will examine one of these algorithms in a system where messages between nodes can be lost and the nodes themselves can crash. This algorithm contains parameters that capture the speed of operations, the minimum and maximum message delay, and the clock skew between nodes. The theoretical correctness proof of the algorithm relies on the parameters being accurate and no processes failing. We have simulated this algorithm so that the parameters and other timing elements can be precisely controlled. We will explore the behavior of the algorithm when the parameters are inaccurate and there are process crashes when focusing on the case where the shared data object is a FIFO Queue.

Subjects: Engineering (STEM)

Sintering Analysis and Characterization of Fused Filament Fabrication (FFF) 316l Stainless Steel

Ahmed Mahfouz and Hamza Ghauri

Faculty Advisor: Bilal Mansoor, Ph.D.

The primary objectives of our research are to analyze microwave sintering and conventional thermal sintering on metal samples produced by way of Fused Filament Fabrication (FFF) 3D printing. FFF is a novel 3D printing technique that promises great reductions in operational costs and hazards over

more traditional metal 3D printing methods such as Metal Injection Molding (MIM), Electron Beam Melting (EBM), and Selective Laser Sintering (SLS). Nevertheless, FFF printed parts require a complex heat treatment process to sinter the metal particles embedded in the polymer-based binding filament. Due to the relative novelty of the FFF metallurgy, there's a limited degree of available literature on the quality of sintered parts which thus raises the need for an experimental study that investigates the different types of sintering alternatives and the parameters thereof with respect to the quality of the final sintered piece. Nevertheless, some early studies have shown that with the proper set of sintering parameters the mechanical properties, density and porosity levels of the sintered part can be on par with those manufactured by conventional more costly metallurgical methods. In this present study, various sintering parameters are investigated to optimize the quality of the final part by way of both, conventional thermal sintering, and microwave sintering.

Subjects: Engineering (STEM)

Software Implementation of Quantum Error Correction

Ahmed Al-Shemmery, Gibin George, and Muhammad Ghasef Paracha

Faculty Advisor: Joseph Boutros, Ph.D.

Quantum technologies, utilizing various quantum mechanical phenomena, carry the potential to overcome the limitations of classical computing and provide superior computational power and exponential speeds. As such, quantum technologies can revolutionize not only vital scientific fields of research but also the entire information age. Due to this tremendous promise, vast resources have been invested in its research by both the public and private sectors. However, due to the nature of quantum mechanics, quantum technologies are far from feasible, and without proper error detection and correction protocols, will remain a theoretical curiosity. In contrast to classical error correction that has been developed since the mid of the twentieth century, the field of quantum error correction (QEC) is in need of substantial development. Even though there are many challenges facing the construction of quantum error correction codes (QECCs), there have been multiple QECCs developed since the mid 90s, each utilizing certain formulations to identify and correct quantum bit (qubits) and, ultimately, improve the reliability of quantum machines. The focus of our research is not to create new QECCs but to develop and improve upon existent codes, exclusively Calderbank-Shor-Steane (CSS) codes constructed using two classical low-density parity-check (LDPC) codes. In order to achieve this objective, the team initially conducted literature review, both on classical and quantum error correcting codes. Select codes were then implemented on a quantum cloud computing software called *Qiskit* provided by *IBM's Quantum Lab*, which provides access to quantum computers and simulators owned by IBM. The research is presently in a phase where the implementation and development of quantum code is in progress.

Subjects: Engineering (STEM)

Software-Defined Wireless Network for Real-Time Sensing

Austin Keith

Faculty Advisor: I-Hong Hou, Ph.D.

Traditionally in the field of electronics, hardware is designed, developed, and improved on in various methods, whether it be increased storage capabilities or smaller models. Software applications lagged because of the hardware requirements to operate software, but increasingly, software tools

are replacing technology that relied heavily on hardware components where applicable because of the abilities to both modify the technology easily and to consolidate tasks in an automated fashion. This research focuses on the networking space and aims to replace hardware architecture with software, as well as write an algorithm to intelligently allocate incoming data.

To orchestrate this architecture and algorithm, the modern tools of software-defined networking and software-defined radios were combined. This created a network capable of transmitting packets over-the-air, with the network itself having separated the data plane and the control plane in the software-defined networking standard. The control plane is written entirely in software, allowing modifications to be made across the whole system relatively simply. In this research, two software-defined radios were used to represent a base station and a field multi-sensor collector respectively. The field sensor radio transmits real sensor data from a web database that represents common units of measurement in a physical environment, such as pressure, temperature, and humidity. The base station radio can only receive a single packet at a time from the secondary radio due to bandwidth constraints, and so, using a software-defined controller, the algorithm chooses the most efficient means of processing the individual data packets. The controller also displays the incoming data in a GUI designed previously by graduate students.

Subjects: Engineering (STEM)

Spatial and Temporal Trends of Gar Habitat Use in a Subtropical Estuary

Anna DeMotte

Faculty Advisors: RJ David Wells, Ph.D. and Emily Meese, M.S.

A basic understanding of species distribution and abundance patterns and how they change relative to abiotic variables is important in order to assess species' niche preference and spatial and temporal habitat use patterns. Estuaries along the Texas coast are known to be highly productive with variable fluctuations in abiotic factors such as temperature and salinity. Depending on the species, fish can withstand a degree of tolerance to these dynamic conditions leading to differing degrees of residency. The family *Lepisosteidae* consists of several species that inhabit the northernmost estuaries in Texas (Sabine Lake), and are primarily considered freshwater fishes. For this study, we are using long-term monitoring (1986-2018) gillnet surveys from the Texas Parks and Wildlife Department to examine spatial and temporal patterns of gar abundance relative to differing abiotic variables. Predictive modelling will allow us to determine spatial and temporal trends in the presence and absence of gar species in an important estuary along the Texas Gulf coast.

Subjects: Science (STEM)

Spatio-Temporal Patterns and Influencing Factors of Florida Panther Roadkills

Tatyana Canales

Faculty Advisor: Hsiao-Hsuan (Rose) Wang, Ph.D.

The Florida panther, *Puma concolor coryi,* has been described as an umbrella species, heavily impacting the ecological community they are in. The Florida panther historically roamed throughout the southeastern United States from Louisiana to southwestern Florida, and has now been limited to wild populations within the southern tip of Florida, specifically Big Cypress National Preserve and the Florida Panther National Wildlife Refuge, due to anthropogenic habitat degradation. Despite the

conservation of the Florida panther, the population continues to experience threats from the continued development of expanding roadways through vital habitat. Hence, the objective of this study is to investigate the spatio-temporal trends of Florida panther road kills and determine the effects of roadway development and automobile traffic on the roadkills. To perform the investigation, data was collected from open access sites, including the Florida Fish and Wildlife Conservation Commission, which was used to create a document with the time and location of roadkills and presences in Florida from 1980 to 2021, and the Florida Department of Transportation, which contained road data from 2011 onward. The data was used to create a map displaying the points of occurrence of roadkills, and overlaid with historical road and traffic data. I then identified potential variables influencing the likelihood of roadkills, and quantified the relative importance of each factor using boosted regression trees. I found that a majority of the cases occurred along rural roads, particularly expressways and major collectors. Of these roads, it was most common for Florida panthers to die by vehicular strike along 2 laned roads that had medians between 20-24 feet, and were often paved or curbed with vegetation. While many roads did not record the average speed traveled, the most common speed seemed to be 60-65mph. These findings indicate that there may be a correlation between the narrow, rural roads surrounding vital habitat, and the continuous increase in Florida panther roadkills. This agrees with the behavioral patterns of the species, seeing that they are known to be elusive, and avoid contact with people, and frequently traversed areas.

Subjects: Interdisciplinary Research, Other

Speeding Up the Prototyping of Low-Fidelity Wireframes

Melissa Zhang

Faculty Advisors: Tracy Hammond, Ph.D. and Paul Taele, Ph.D.

Prototyping for user interfaces (UIs) is essential when it comes to giving an idea for how the final result will look and function. This allows both designers and stakeholders to test if all the project requirements are being fulfilled and the functionality of the UI, saving time and money further down the road when the final product is being made. However, current established prototyping tools have an emphasis on visual aesthetics without support for quickly producing low-fidelity prototyping. This leads to the initial prototyping process to be time-consuming and labor-intensive as designers need to start from scratch. In this research, we propose a solution that hopefully speeds up the low-fidelity UI prototyping process by streamlining the workflow. Based on previous research of scenario-based UI design and utilizing UI design patterns and sketching, a plugin tool was created to guide the creation of low-fidelity wireframe prototypes. We then conducted a user study through convenience sampling and evaluated the proposed prototyping workflow through qualitative and quantitative metrics. We hope that our tool helps provide an alternative way for designers and stakeholders to speed up the prototyping processes.

Subjects: Technology (STEM)

Study on the Enhancement of Completion Fluids Corrosion Properties in Petroleum Production System

Rand Alagha and Afsha Shaikh

Faculty Advisors: Albertus Retnanto, Ph.D. and Rommel Yrac, Ph.D.

Corrosion has remained a worldwide challenge in petroleum production systems and still prevails. The focus of this research is on the use of corrosion inhibitors to treat completion fluids to minimize effects of corrosion. In this research, properties of completion fluids and the factors affecting corrosion will be studied in detail. Through this study, we aim to demonstrate the relation of temperature and pressure at different ranges in effectivity of corrosion inhibitors and completion fluids. Corrosion is defined as natural and continuous degradation of materials due to chemical or electrochemical and mechanical reactions. Presence of electrolytes, oxygen, impurities of metallic surface etc. can result in corrosion. Hence, the need for appropriate corrosion inhibitors must be addressed that will also consider its efficiency and assist the company in monetary profits.
The completion fluids prepared for this research are Potassium Chloride (KCl), Sodium Chloride (NaCl), Sodium Bromide (NaBr), Calcium Chloride ($CaCl_2$) and Calcium Bromide ($CaBr_2$). Corrosion inhibitor treatments were performed at different temperature conditions of 180°F and 280°F. Potassium and Sulfite based corrosion inhibitors were added to completion fluids in small concentrations of 1.5%, 3% and 4.5% and left to mature for about 100 hours in OFITE Corrosion Tester. The corrosion plate was removed and cleaned to determine the corrosion rate. The same process was then repeated for an equal mixture of Phosphate and Sulfite based inhibitors amounting to the same total concentration.

It is expected that adding an equal amount of phosphate and sulfite-based inhibitors in the completion fluid will be more economical and effective than individual inhibitors in lower temperatures. While comparing the phosphate and sulfite-based inhibitors, phosphate-based inhibitor was a better option at both High Temperature and High Pressure (HTHP) conditions and Low Temperature and Low Pressure (LTLP) conditions. Out of the five completion fluids, divalent brines are identified as better completion fluids at higher concentrations for both temperature conditions. This is because they reduce corrosion rate and conditions as compared to the monovalent brines. NaBr had very similar performance to that of the divalent brines when sulfite-based inhibitors were used at LTLP conditions.

This research facilitates the understanding of inhibiting corrosion effectively in an economically feasible manner. Another novel aspect is that materials used for this study are also used in real petroleum production field operations making the findings of this study more realistic, beneficial and incorporative in the industry. These protective inhibitors may grant more access to reaching deeper reservoirs successfully. Furthermore, this research will positively impact the economy as formation damage is likely to reduce and hence the need to shut the well due to failure in tackling corrosion issues.

Subjects: Engineering (STEM), Science (STEM)

Survivor Buddy: An Overview

Osric Nagle

Faculty Advisor: Robin Murphy, Ph.D.

This presentation goes over the current state of the Survivor Buddy project, including relevance to current issues, implementation details, improvements, and next steps. This project will significantly improve the control and reliability of the Survivor Buddy 4.0 robot by creating semi-autonomous behaviors to automate social interaction and by adding reflexive feedback loops, including sensors if needed, to prevent damage from things like burning out motors while attempting to move when blocked.

Subjects: Engineering (STEM)

Targeting Tumor-Lymphatic Crosstalk to Inhibit Progression of Liver Cancer

Rahul Chauhan

Faculty Advisor: Sanjukta Chakraborty, Ph.D.

Cholangiocarcinoma (CCA), a cancer of the intrahepatic and extrahepatic biliary epithelium is aggressive, clinically silent and has a dismal prognosis. Tumor-associated growth of new lymphatic vessels or lymphangiogenesis, predicts unfavorable prognosis of CCA and tumor metastasis to the draining lymph nodes (LN) is the primary indicator of adverse outcome. There is an unmet critical need to identify novel therapeutic strategies for CCA management, and thus, in this project we evaluated how specific chemokines produced by CCA tumor affects LEC growth, proliferation and lymphangiogenesis while also promoting metabolic changes. We first identified the CXCR2-CXCL5-YAP signaling axis that mediates interaction between tumor cells and lymphatics. This signaling axis has been found to increase lymphangiogenesis and tumor migration within cholangiocarcinoma. Furthermore, this signaling axis also is linked to significant cytokine-chemokine production within the tumor microenvironment. Using liver cancer cell lines and lymphatic endothelial cells, we identified the cytokine chemokine production by conducting cytokine arrays which showed IL-1β and TNF-α, among others. Subsequently, we analyzed these identified cytokines chemokines by observing how their production affect LEC migration through migration assays. It showed that increased production of these cytokines was correlated with increase tumor metastasis. Also, we watched how lymphangiogenesis was affected through tube formation assays, presenting similar results as we observed increased tube formation with increased cytokine production. We followed molecular signaling patterns through real time PCR of adhesion molecules (CAM1, VCAM1, and MCP1), cytokines, and chemokines.

Subjects: Health and Medicine (STEM), Science (STEM)

The Anti-Feminicide Movement in Ciudad Juares: Women's Activism and New Articulations of Justice

Marla Guerra

Faculty Advisor: Chaitanya Lakkimsetti, Ph.D.

The issue of feminicide in Ciudad Juarez was first exacerbated by the notable shift towards the implementation of a neoliberal economic system in the early 1990s, which motivated by profit ultimately allowed for the exploitation of young women within this region and as a result normalized views of their disposability. In response to the frequent occurrence of legal impunity within cases of feminicide, local activist groups and international NGOs have collectively participated in past public demonstrations, transnational initiatives, and ‘artivism’ campaigns in hopes of providing a foundation for social justice. Although significant attention drawn from the global public has persuaded the Mexican government to enact a few changes in the past, these however, have proved to be rhetorical commitments towards improving gender justice. Therefore, an examination of anti-feminicide activism generated from Ciudad Juarez since the 1990s should provide an in-depth analysis to the various outlets of activism utilized within this region, while also depicting the events leading prior to its criminalization. By deciphering the aftermath of activist campaigns post-criminalization, this will offer considerable insight into their rearticulation of new meaning for justice

when faced with a failed legal system. Similarly, an analysis of this movement's evolution can offer possible future approaches towards holistically addressing the global issue of gender-based violence.

Subjects: Arts and Humanities

The Blood Threshold: An Examination of Eugenics and Genetic Discrimination in the Fantasy Genre

Emily Curtis

Faculty Advisor: Lowell M. White, Ph.D.

In speculative fiction, genetics is a prevalent but unequally explored topic between genres. Though often disguised by terminology and aesthetics, many classic fantasy tropes, such as a hereditary magic system, portray humanoid cultures that face issues of governmental or societal pressure to select for certain traits. Methods of enforcing these goals can amount to positive or negative eugenic programs.

Although the genre has long-since been a testing ground for ethical issues through fantasy cultures, rarely is this strength applied to topics of eugenics and genetic discrimination. Due to different expectations of the genre, fantasy often presents, but rarely pursues, the true ramifications of such ideology, resulting in problematically underdeveloped and oversimplified discussions about increasingly relevant human ethics.

This project seeks to employ the strengths of the genre and confront its shortcomings in bioethics discussion. First, it examines the existing portrayal and discussion of eugenics and genetic discrimination in the fantasy genre through review of popular young adult and adult novels. Second, it answers the question of what a eugenics-based society could look like through a creative artifact, the first five chapters of a novel, *The Blood Threshold.* Informed by prominent novels of the fantasy genre and by the Western eugenics movements between the 1900s to 1950s, *The Blood Threshold* explores a world of magical abilities passed through family lines, a culture centered around the accumulation of favorable genetics, and a cast of characters confronting the tenets of their society.

Subjects: Arts and Humanities, Creative Works, Health and Medicine (STEM), Interdisciplinary Research, Social and Behavioral Sciences

The Coloniality of Cosmetics: Resistances to Colonial Determinations of Gender

Valeri Cangelosi

Faculty Advisor: Omar Rivera, Ph.D.

Colonized individuals are often subjected to gender systems that follow what critic and philosopher María Lugones describes as a dichotomous hierarchy of "the human" versus the "non-human" in colonial and post-colonial settings. I use this oppositional structure and a colonial lens to focus on how an altering of the body, either through cosmetics, tattoos, or fashion could be read as a practice that reflects elements of colonialism. I explore the differences between how makeup affects categorial oppositions such as white women versus women of color, white men versus men of color, white transgender individuals versus transgender individuals of color, and so on. Other components of my thesis will analyze how makeup and fashion play into different dynamics of oppression to both

reinforce colonialism in the makeup industry and compare how people are “playing” with their own makeup as a means of resistance to the makeup industry and stereotypes. My thesis, “The Coloniality of Cosmetics: Resistances to Colonial Determinations of Gender,” places emphasis on the works of Lugones that focus on decolonial feminism, including The Coloniality of Gender and Towards a Decolonial Feminism. It also focuses on the effects of social media on the cosmetic industry, and how it has shaped constructions of gender across racial differences.

Subjects: Arts and Humanities

The Coupled Effect of the Pore Angularity and Wettability on the Dynamics of Immicible Displacemnet

Shabeeb Hayajneh, Ward AlBashtawi, Abdallah Elzamli, Lukman Kazeem, and Omar Aly

Faculty Advisors: Albertus Retnanto, Ph.D. and Harris Rabbani, Ph.D.

In many natural and engineering applications, the dynamics of immiscible displacement in porous media plays a critical role, including infiltration of rainwater into the soils, CO2 geosequestration, enhanced oil recovery, fuel cells, microfluidics and printing. While the impact of wettability on immiscible displacement is well understood, the interplay of wettability, geometry, and disorder of the porous matrix in the displacement process remains elusive. In this research, the focus will be on investigating the pore angularity and wettability's coupled effect on the pore-scale dynamics of immiscible displacement using a computational fluid dynamic modeling approach. The numerical simulations were performed using OpenFoam on several porous media (designed using CAD software) of different pore angularity and viscosity ratio with a wide range of wetting contact angles. Our investigation improves the fundamental understanding of multiphase flow through porous media and paves the way for the interpretation and further investigation of wettability control on multiphase flow in natural and engineered porous media, which often exhibit spatial heterogeneity in pore angularity.

Subjects: Engineering (STEM)

The Effect of Fire on Nematode Community Structure

Paige Wirth

Faculty Advisors: Peyton Smith, Ph.D. and Charles Lafon, Ph.D.

Forest management strategies, specifically prescribed burns, are becoming more common as the benefits of management are brought to light. Prescribed burns emulate the natural fire regime of the area. The pine forests on state and federal land in eastern Texas are frequently burned, with many stands burned on 3 to 10 year rotations. Prescribed burning helps to eliminate invasive species, encourages growth of pyrophytic species, and maintains habitat for native wildlife. The introduction of fire into an ecosystem also alters the soil in the area. Burning removes nutrients and adds carbon to the soil through depositing biochar (Certini, 2005). These abiotic factors as well as the physical heating of the soil during a fire change the microbial community in the soil. Nematode communities are one category of microorganism that has been found to change post-burn (Butenko et al, 2017). This study examines the ways in which the nematode community’s trophic structure changes post-controlled burn in the Fairchild State Forest in eastern Texas. It does so through a series of soil samples taken from Loblolly Pine stands. There are five composite samples in each category: Unburned, Immediately after burn, 1 year post burn, 2 years post burn, and 4 years post

burn. Nematodes were then extracted using the Baermann Funnel protocol, and trophic groups were identified for each plot using the method outlined by R. Niles in *Identification of Nematode Feeding Groups* (1994). Tests measuring the soil pH, nitrogen, phosphorus, potassium, calcium, sodium, sulfur, and magnesium contents, conductivity, and organic matter content were also conducted. Results were then analyzed using (insert statistical test used) to understand the relationship between nematode abundance and factors tested for in the lab, as well as years post fire and nematode abundance.

Subjects: Science (STEM)

The Effects of Investigator Disturbance on Nesting White-Tailed Hawks in South Texas

Brianna Simonds

Faculty Advisor: Michael Morrison, Ph.D.

The white-tailed hawk (*Geranoaetus albicaudatus*) is a common hawk in Central and South America with only one subspecies (*G. a. hypospodius)* that is as far north as the Texas coast. Despite being classified as a state-threatened species in Texas, little is known about the white-tailed hawk's life history and the demographics of its population. Suitable nesting areas are becoming more sparse and the lack of information on the shy species can make it difficult to identify how land managers can better apply protection for our resident raptor. The few studies done in the past all show that the white-tailed hawk is sensitive to nest disturbance. Data analyzing the result of disturbance on the nesting bird of prey could be essential in managing this state-threatened species. In my study, I will attempt to look at the disturbance impacts on nesting white-tailed haws by analyzing how adults behave around the nest site during disturbance events. The adult hawk leaving the area may hurt nest success by causing the young to be exposed and alone. To learn more about the hawk's disturbance reactions, I will be looking at the amount of time the adults leave the nest after nearby anthropogenic activities and study possible impacts. I will be using videos already captured by cameras placed at white-tailed hawks nests among several distinct areas in south Texas during the summer of 2021. My data collection is underway and I will continue on with this study in the course of a year.

Subjects: Science (STEM)

The High Stakes of Outsourcing in Health Care

Sunjay Letchuman

Faculty Advisor: Leonard L. Berry, Ph.D.

Outsourcing in health care has become increasingly common as health system administrators seek to enhance profitability and efficiency while maintaining clinical excellence. When clinical services are outsourced, however, the outsourcing organization relinquishes control over its most important service value: high-quality patient care. Farming out work to an external service provider can have many unintended results, including inconsistencies in standards of care; harmful medical errors; declines in patient and employee satisfaction; and damage to clinicians' morale and income, and to the health organization's culture, reputation, and long-term financial performance. Research on outsourcing in the areas of emergency medicine, radiology, laboratory services, and environmental services provides concerning evidence of potentially large downsides when outsourcing is driven by short-term cost concerns or is planned without diligently considering all of the ramifications of not

keeping key clinical and nonclinical services in-house. To better equip health system leaders for decision-making about outsourcing, we examine this body of literature, identify common pitfalls of outsourcing in specific clinical and nonclinical health services and scenarios, explore alternatives to outsourcing, and consider how outsourcing (when necessary) can be done in a strategic manner that does not compromise the values of the organization and its commitment to patients.

Subjects: Business, Health and Medicine (STEM)

The Impact of Animal Companions on Neurodivergent College Students

Hannah Hacker, Amarpreet Kaur, Jacob Quintanilla, and Brianna Noska

Faculty Advisors: Christopher Quick, Ph.D. and Marissa Cisneros, Ph.D.

Objectives: The Neurodivergent community has different social and mental processes due to genetic and/or environmental factors that impact interaction with neurotypical settings. There is a disparate number of college students with neurodiversity, possibly due to struggles with anxiety due to a new social environment and classes. Numerous studies have shown that animals boost social, mental, and physical health within challenged communities, such as children with autism. However, there is little research on animal companionship assisting in the transitioning process into the new settings of higher education for neurodiverse college students. The purpose of this research is to explore the impact of animal companions on the mental and social health attitudes of neurodiverse college students. Our research question is- How do pets affect the *social health*, the mental health of neurodiverse college students, and the transition of first-year neurodiverse college students?

Methods: Mixed methodology was used within a survey containing both quantitative and open-ended questions to uncover the benefits of companion animals on neurodiverse students. Data will be collected from both those who do and do not own animals. Students who choose to answer the survey will answer questions based on their social and mental health and their first year of college. Students who own pets can answer questions based on their pets and how they helped them through their first year of school.

Conclusions: As shown, pet therapy treatments have been reliable for trauma, anxiety, physical health, and social improvement. There have been plenty of studies showing these improvements in veterans, addiction, children with ASD, prisoners, and more. However, while many studies show these improvements, there is a lack of information on pet therapy aiding college students grappling with Neurodiversity. There is an inadequate number of students who have Neurodiversity in college, which could be because of the stress and antisocial behavior, causing a lack of numbers. Using the data collected from other resources that use pet therapy; could show improvements for college students who have Neurodiversity and possibly increase students' numbers to go to college.

Practical Implications: The benefits of companion animals have not been thoroughly researched on neurodiverse college students, and therefore they may not be aware of the valuable possibilities this resource brings. The data will be used to discover the effects pets have on the transition to college for neurodiverse students in their first year of school. However, there is little research on higher education settings on neurodiverse college students. There is an inadequate number of students who have Neurodiversity in college, which could be because of the stress and antisocial behavior, causing a lack of numbers. Using the data collected from other resources that use pet therapy; could show improvements for college students who have Neurodiversity and possibly increase students' numbers to go to college.

Subjects: Science (STEM)

The Impact of Progressive Era Women's Organizations on the Passing of the Proposed 1924 Child Labor Amendment to the United States Constitution

Jannah Burgess

Faculty Advisor: Katherine Unterman, Ph.D.

The Impact of Progressive Era Women's Organizations on the Passing of the Proposed 1924 Child Labor Amendment to the United States Constitution provides a summary of the roles of women's organizations in the Progressive Era United States in the anti-child labor movement, specific to the creation and lifespan of the proposed Child Labor Amendment to the Constitution. The proposed amendment would have given Congress the power to regulate the labor of all persons under eighteen. The thesis is divided into three parts. Part one will explain why lawmakers thought the best way to pass national legislation was by way of a constitutional amendment, shown by providing an analysis of previously attempted federal anti-child labor legislation. Part two pertains to how the amendment succeeded in Congress, focusing on the involvement which women's groups had on the passing of the amendment and in helping the anti-child labor movement gain larger awareness amongst both lawmakers and the general public. Part three of the thesis covers the timeline of the amendment from its passing until its expiration in 1937 due to unsuccessful ratification. The section will cover major oppositions to the amendment by different lawmakers at the local, state and federal levels, factory owners, and other individuals and interests groups. This will answer the question - Why did the amendment fail to get enough state ratification? The overall goal of the thesis is to document motivations for the amendment's creation, how women's organizations aided in its passing, and why the amendment was ultimately not ratified.

Subjects: Arts and Humanities

The Metabolic Effects of Different Temperament Categories in Angus Heifers and Brahman Steers

Abigail Tack

Faculty Advisor: Chris Kerth, Ph.D.

Meat products are priced based primarily on quality. Therefore, it is important in the beef industry for producers to be able to ensure that they are raising the highest quality cattle possible. There are three major temperaments associated with cattle – calm, intermediate, and temperamental - and research has shown that temperamental cattle are more likely to produce dark-cutting cattle resulting in a lower quality product. Dark cutting occurs when an animal has experienced long-term stress 24 to 48 hours prior to harvest that results in it having less glycogen available for use in the conversion of muscle to meat. My research aims to identify specific metabolites and their prominence in the blood serum of cattle that are associated with the three different cattle temperaments. The goal is to find metabolites that can be associated with a specific temperament group to eventually indicate how certain animals will perform post-slaughter. Cattle that are identified as more likely to be at risk of producing a lower quality product can be catered to in order to reach a higher value product. To research this, blood serum samples from Angus heifers and Brahman steers utilized in a temperament study were extracted and run through a high-performance liquid chromatography-quadrupole time-of-flight (HPLC-qTOF) machine to identify and quantify the metabolic compounds present. I hypothesize that the temperamental cattle will have

higher concentrations of specific identified metabolites in their serum when compared to the calm and intermediate groups. I also predict that the same metabolites will be elevated in the temperamental cattle of both the Angus heifers and the Brahman steers.

Subjects: Science (STEM), Other

The Paradox of Urban Green Space and its Potential Contribution to Green Gentrification

Macy Fetchel

Faculty Advisor: Charles R. Hall, Ph.D.

Human interaction with plants and green spaces brings about a plethora of economic, environmental, and well-being benefits for communities and individuals. These benefits have increased the popularity of urban green spaces and infrastructure amongst urban planners and municipal leaders. One of the most prevalent economic benefits is the resulting increase in property value from the proximity to these green spaces. These increased property values however, have the potential to displace the original, long-term residents of these areas and instead draw in higher-income individuals with the means to afford higher prices. This trend has been deemed as “green gentrification” in the literature and has been shown to contribute to the lack of uniformity in the spatial distribution of green spaces. As a result, lower average household income levels often lack access to these spaces and are excluded from the benefits provided, leaving these populations more susceptible to decreased air quality, the urban heat island effect, and other externalities associated with poor infrastructure. There are numerous studies cited in the literature pertaining to the benefits of “urban greening”, though limited studies regarding the “socio-spatial” implications and the potentially negative effects on lower income populations. This paper seeks to analyze the potential for green gentrification resulting from higher property values, and the trend’s contribution to environmental justice. Through evaluating the empirical evidence of increased property values as well as what exists of the green gentrification literature and demographic trends, this research will seek to provide a much-needed consensus on the scope, theoretical approaches, and mitigation opportunities regarding green gentrification.

Subjects: Business, Science (STEM)

The Perceptual Rubber Hand Illusion: How Augmented Stimuli Affects the Illusion

Rebecca Schultz

Faculty Advisor: Hangue Park, Ph.D.

The purpose of this research is to both bolster the reproducibility of the Rubber Hand Illusion, a perceptual illusion involving body ownership and extended body schema, and to determine if this illusion can be successfully induced in participants through the use of synchronous augmented tactile feedback in the form of electrical stimulation of the finger. This is accomplished through multisensory integration using proprioception, visual stimuli, and synchronous tactile stimuli.

The objective of the research described henceforth is to extend the body schema to a rubber hand outside of the original body image. While the participant observes manual synchronous tactile stimulation in the same relative location on a rubber hand, the person will receive augmented tactile stimulation on their own hand. The ownership of the rubber hand will be evaluated by a stress test accompanied by the physiological measurements and followed by a short questionnaire.

The development of the electrical stimulator used in this study is also part of this research. The device will be developed for use in body ownership research where experimenters may select how sensitive they would like the detection of pressure to be which triggers stimulation, the frequency and duty cycle of the biphasic signal generated, and the amplitude of stimulation.

Once the study has been conducted, the data will be analyzed to determine if body ownership of the rubber hand was successfully attained in both set-ups: the original Rubber Hand Illusion, and the augmented Rubber Hand Illusion. This will be determined by looking at subject reports in the questionnaires as well as looking for spikes in heart rate, pulse, and skin conductance response at the time during which the threat was introduced.

Subjects: Engineering (STEM)

The Presence of Cosmetic Surgery Practices on Social Media: An Analysis on Ethics

Georgia Elgohary

Faculty Advisors: Timothy Phillips, M.S., Ph.D., ATC, TAL and Christopher Lee, Ph.D.

Throughout human history, society has regarded certain physical characteristics and traits as "beautiful." Individuals have gone to extreme measures to live up to these standards, and cosmetic surgery is today's solution for people who wish to adhere to what society deems as aesthetically pleasing. People often credit social media as being the primary method of enforcing these standards for physical appearances. Research has shown that continuous exposure to photo-sharing sites has caused an unnatural expectation of body image. As a result, many people suffer from body dissatisfaction, a condition when an individual feels that he or she does not meet society's standard of what is considered beautiful and consequently has negative feelings about their physical traits. As the number of Americans using social media for personal purposes has increased significantly over the past few decades, the number of businesses utilizing these platforms as an advertising tool has increased as well. Given the role of cosmetic surgery in assisting individuals achieve a certain appearance, it has been questioned if the presence of cosmetic surgery practices on social media worsens this elevated standard of beauty. This study explores the ethical standards these accounts uphold. 417 Instagram accounts and 554 Facebook accounts were reviewed and categorized by use of the platform to promote cosmetic surgery or to educate individuals on this specialty.

Subjects: Social and Behavioral Sciences

The Role of the Fragile X Mental Retardation Protein In Synaptic Changes Observed On D1 Dopamine Receptor-Expressing Striatal Medium Spiny Neurons Following D1-Agonist Exposure: An Investigation in Cortical-Striatal Co-Culture

Elizabeth Harrison

Faculty Advisor: Laura Smith Ph.D.

This experiment seeks to investigate the effect of a drug like exposure on the number of functional synapses in a primary cortical-striatal co-culture with wild-type (WT) striatal medium spiny neurons (MSNs) expressing dopamine 1 (D1) receptors compared to FMR1 knockout (ko) MSNs which are not expressing the fragile X mental retardation 1 gene. The fragile X mental retardation protein assists in regulating synaptic function; the absence of this protein, known as fragile X syndrome (FXS) has been

associated with autism. Striatal activity specifically influences behaviors of reward and motivation. Previous research has found MSNs lacking FMRP have considerable deficits in dendritic spine density and colocalized synaptic puncta compared to WT following a drug like exposure. However, this research observed both D1 and D2 striatal neurons, and these neurons operate within different pathways. D1 receptors cells are assumed to drive behavior when activated as part of a direct pathway. This study will expand on the differences between D1 and D2 type neurons as well as investigate more thoroughly the impact of the FMRP on specifically D1 MSNs. Preliminary data has suggested WT MSNs experience a greater loss of functional synapses following a drug like exposure compared to ko MSNs suggesting FMRP is likely critical to the direct pathway. More data is required to determine statistical significance.

Subjects: Science (STEM)

The Science and Progression of Data Science in Football

Jaime Cepeda Jr.

Faculty Advisor: Hyun-Woo Lee, Ph.D.

In recent years, we have seen how technology has changed society and has made it far easier and more feasible to connect with people around the world, paving the way for multi-functional devices, and creating evolutions that will change the history of inventions created in the past. Technology has played a vital role in the evolution and progression of football, as it has led to various ideas and implementations never seen before without the growth and influence of technological devices. Through qualitative interviews using Grounded Theory Approach, I worked alongside multiple clubs to gain insight into data analytics emerging among and considered by the Board of Directors. This study emphasizes the importance and evolution of data analytics and how it demonstrates improved better player performance, creation of better tactical formations, and injury prevention and preparation. Using the Player Performance Index, analysis shows a strong correlation with the improvement of better player performance by keeping track of certain statistics needed by sports analysts. Various methods of changing tactical styles and in-game tracking have facilitated football clubs to determine what will be their best approach to creating the ‘‘tactical formation’ by having data analytics tools such as optical tracking facilitated by software programs. Although data regarding injuries in football clubs is impossible to receive due to privacy protection laws, through the qualitative interviews, information is presented describing how training loads can be modified by using indices and balances created by sports analysts to minimize the risk of injuries between players through better preparation. We conclude that there is sufficient evidence to demonstrate how data science has evolved football.

Subjects: Science (STEM), Social and Behavioral Sciences

The Weird Year: Reactive Weirding in the Post-Pandemic Age

Rain Etheridge

Faculty Advisor: Jason Harris, Ph.D.

When considering destructive, traumatic, or paradigm-shifting historical events and periods, the inevitable transformation of literature makes itself obvious. Literature continually reacts to and interpolates the world in which it is conceived, creating reactive movements that correspond to certain historical contexts as authors and readers struggle to make sense of the world around them.

In the modern context, this can be seen in a phenomenon referred to as “reactive weirding,” in which periods of rapid social and historical change cause previously inert or mainstream authors to begin exploring the weird mode. Clearly visible in response to events such as the Spanish flu epidemic, World War II, the bombing of Hiroshima and Nagasaki, instability in Colombia, the rise of television and the internet, 9/11, and of course the COVID-19 pandemic, reactive weirding provides a framework for understanding the motivations and goals of authors who choose to blend genres by entering strange spaces.

This most directly relates to the current moment in discussion of the COVID-19 pandemic. As nations, organizations, and especially individuals begin to emerge from the pandemic context and enter the irrevocably changed post-pandemic, the discontinuity of experience, time, and pain are already coalescing into the foundations of a “New ‘New Weird.’” This emerging subgenre, incorporating elements of horror, magical realism, science fiction, metamodernism, and folk, may form the bedrock of the post-pandemic literary imagination. Understanding this movement in its entirety is crucial if we are to make sense of the weird new world we find ourselves in, now and hereafter.

Subjects: Arts and Humanities, Creative Works

To Dine For: The Making of Cartoon

Morgan Sumner

Faculty Advisor: Samuel Woodfin, MFA

To Dine For is a pilot cartoon and a thesis film that follows a young waitress named Bella Cadvere as she is introduced to her new life among the dead. The singular episode will reach a time between fifteen to twenty minutes presenting the ideas of acceptance of death, femicide, and how death can be presented in a humorous light. The purpose of the pilot itself is to be pitched later and turned into a full television series for young adults. The project will go into the most effective way to create a 2D animated pilot, with 3D assets, that is appealing both visually and story wise with the ultimate goal of creating a full animatic with sound, creative writing, and dynamic visual storytelling.

Subjects: Creative Works

To What Extent is the National Pre-Conception and Pre-Natal Diagnostics Techniques (PNDT) Act of 1994 Effective?

Kirsi Singh

Faculty Advisor: Alexander Pacek, Ph.D.

India currently observes an alarmingly low child sex ratio regarding females. The 2011 Indian National Census found that the child sex ratio had reached an all-time low of 914 girls to 1000 boys. The low child sex ratio in India can be attributed to practices of sex selective abortions against female babies. The Indian government acted against this practice in 1994 with The National Pre-Conception and Pre-Natal Diagnostics Techniques (PNDT) Act. The goal of this paper is to examine the effectiveness of The National Pre-Conception and Pre-Natal Diagnostics Techniques (PNDT) Act now that almost three decades have passed since its implementation. Statistical modeling will be used to analyze trends between variables such as the overall population, child sex-ratios, and overall sex-ratios. Data from the year of implementation of the act in 1996 to current times in 2021 will be

used in order to create a longitudinal study. This information will primarily be found from the past three official Indian census as well as multiple National Family Health Surveys. Although the data has yet to be analyzed, it is anticipated that the PNDT Act will prove to be slightly efficient, and that the child sex ratio would be worse without the act.

Subjects: Arts and Humanities

Top-K Item Recommendations for Content Curation Platforms Using a Graph Convolutional Autoencoder

Charles Im

Faculty Advisor: James Caverlee, Ph.D.

There are millions of users using applications where content creators (curators) create items or content for the users to consume. With users spending more and more time on these platforms, personalized recommendations incentivizes users to consume more content. Much research has been done to improve the performance of the systems but the process of using a graph-based relationship to map the users and curators is still a largely new topic that has the potential to capture the relationships between users, content, and curators. In this paper, we propose a graph-based convolutional autoencoder recommender system for top-K item recommendations for each user. Our model, consisting of a graph convolution preprocessing step, attempts to capture the interactions between users and curators and uses a similarity calculation to denoise additional unneeded data by creating a graph-based structure between users and curators. After the preprocessing step, our architecture consists of an autoencoder to provide item recommendations given a user. We compare the results of our model to current state of the art recommender systems and offer insight into the noise that impacts the relationship between users and curators. We demonstrate that our model performs similarly to current state of the art models and provide future directions that require more research.

Subjects: Technology (STEM)

Ultrasound 3D Reconstruction using Speckle Tracking

Jacob Ruff

Faculty Advisor: Raffealla Righetti, Ph.D.

Ultrasound (US) has been proposed as a possible replacement for traditional computed tomography (CT) scans in imaging orthopedic structures in the human body. One of the main challenges in adapting Ultrasound for this application is stitching together US frames to produce a reconstructed 3D image. The goal of this project was to produce an analysis of the feasibility of using speckle correlation curves for the reconstruction of Ultrasound images collected from a freehand US probe. US computer simulations of the experimental process were performed using Matlab's Field II. The US simulations produced correlation curves created from simulated virtual phantoms. The error of predicted positions based on a correlation curve was within .2 mm across all shift distances and the different tested depths. After completing simulations, we moved on to an analysis of real data. To produce true position data, we optically tracked the US probe as we collected data off of a phantom. Manually syncing the US and position data together, we produced a correlation curve for the experimental data.

Subjects: Engineering (STEM)

Under the Attic and Above the Basement: The Lasting Effects of Childhood Abuse

Olivia Alexander

Faculty Advisor: Jason Harris, Ph.D.

This is a creative thesis that examines cycles of abuse within households through the eyes of children and young adults. Abuse isn't always obvious and physical which is an aspect that is a central topic in most of these short stories. The research done to create this collection focuses heavily on the lasting mental effects domestic abuse has on its victims, including the ways in which it can affect future generations. Each story within the creative artifact focuses on a different child or young adult within a family and how they deal with the trauma that is given to them by their parents, either consciously or unconsciously. All the stories within the collection are a part of the horror genre which allows for a deeper exploration of abuse through metaphors, rituals, and so forth. Some of the stories utilize creatures, giving the abuse a physical appearance that can be more visceral for readers. Sibling dynamics within abusive households is another aspect that is touched on, specifically how two or more individuals within the same household can be affected by abuse in different ways that aren't always the same. Each narrative delves into different types of abuse and how that particular family decides to deal with their faults.

Subjects: Creative Works

Undergraduate Students' Perceptions of Texas A&M University's Core Values

Jose Solis

Faculty Advisor: Gary Wingenbach, Ph.D.

Texas A&M University has six core values as a framework for its members' civic development. Integrity plays a vital role for upholding these values. As the Exemplary Academic Integrity Project (2013) noted, "Academic integrity means acting with the values of honesty, trust, fairness, respect, and responsibility in learning, teaching and research. It is important for students, teachers, researchers, and all staff to act in an honest way, be responsible for their actions, and show fairness in every part of their work. Staff should be role models to students." To uphold the core value of integrity, students must demonstrate it through their academic and social lives. In the context of academic misconduct, integrity is crucial because it encompasses the essence of other core values.

Although online cheating affected universities nationwide, Texas A&M University was not exempt from this epidemic. Hobbs (2021) reported, Texas A&M University experienced a 50% increase in cheating allegations during fall 2020 semester, with 193 students self-reporting based on one incident. However, this single incident of academic misconduct called into question Texas A&M's core values. McGee (2020) reported, Texas A&M students were found using Chegg, an online tutoring website, to gain answers in an online finance class. Even though some students self-reported these instances of academic misconduct, the stress caused by the COVID-19 pandemic may have affected students' core values negatively. As educators noted, pressures and stresses, resulting from the pandemic, are a major reason for cheating amongst students (Hobbs, 2021). Did the COVID-19 force pandemic force students to violate Texas A&M's core values, especially the value of integrity? Were students willing to risk their integrity by cheating on an assignment or exam? Would they also cheat in face-to-face classes after social distancing was no longer required? If the negative

effects of COVID-19 were real, were they also temporary for students meeting in online classes? These questions merit further investigation to determine if COVID-19 changed students' beliefs about integrity, academic misconduct, and moral values.

Subjects: Social and Behavioral Sciences

Understanding Variation in Cottonseed Oil Percentages

Shreya Veeravelli

Faculty Advisor: Steve Hague, Ph.D.

Cottonseed grown in the US is either crushed as an oilseed or used by dairies in feed rations. While more than 85% of a cotton crop's value is from the lint, the seed represents an important economic component of the cotton industry. Over the past few decades, cotton seed size has been trending downwards, as plant breeders have been selecting for seeds with a higher ratio of lint to seed weight in an effort to increase lint yield. Consequently, the value of the cotton seed has declined. To ultimately regain value within the cotton industry, cotton producers need to grow a crop with a large seed size and high oil content while maintaining high lint yields and fiber quality. The objective is to determine the current relationship between seed size, oil content, and lint yield among current cotton varieties grown by US cotton producers. Replicated field trials were grown at six locations in Texas with 25-40 entries of commonly grown cotton varieties. Measurements included lint yield, lint percentage (ratio of lint to seed weight), HVI™ fiber qualities, seed index (weight in grams of 100 seeds) and oil content. The oil content was measured by time domain nuclear magnetic resonance (TD-NMR) as described by the AOCS. Data was analyzed in an ANOVA using SAS version 9.4 with PROC GLM. Because cotton variety entries varied by location, each location was analyzed separately. Lint yield, lint percent, all fiber traits, seed index, and oil content were different among cotton varieties at all locations. There was an inverse relationship between seed size and lint percent, but there were several cotton varieties in which lint percent and seed size were both relatively high. This suggests that the traits may not be inextricably linked and plant breeders can develop germplasm with both improved traits. In addition, there did not appear to be a relationship between seed quality (size and oil content) and fiber quality, which suggests those are independent traits.

Subjects: Science (STEM)

Uniform Acceleration Radiation of a Scalar Source

Timothy Bates

Faculty Advisor: Stephen Fulling, Ph.D.

We consider several definitions of radiation and apply them to the situation of a uniformly accelerating source in a massless scalar field. We explore several notions of radiation and seek to answer 1) whether they are consistent and 2) explore what these definitions reveal about the nature of uniform acceleration radiation. This work also explores a charge turned on/off in finite time. The 'paradox' of the equivalence principle is addressed for massless scalar fields and we find that a consistency with the equivalence principle is achieved with a scalar source when we consider the energy to be the conserved quantity generated by the associated (Minkowski, Rindler) time translation Killing field.

Subjects: Mathematics (STEM), Science (STEM)

Using Raman Spectroscopy to Differentiate Between Genospecies of Borrelia in Mouse Blood

Nicolas Goff

Faculty Advisor: Dmitry Kurouski, Ph.D.

Lyme disease (LD) is a tick-borne illness caused by the bacterial genus *Borrelia*, most notably *B. burgdorferi*. LD is notoriously difficult to diagnose both by serological assays and polymerase chain reaction (PCR) because of the pathogen present in the bloodstream only for a limited period of days post-infection. After that, the pathogen migrates to muscles and connective tissues, which results in false-negative results. We hypothesized that *Borrelia* can cause substantial changes in blood biochemistry that can be detected and identified by Raman spectroscopy (RS). Our findings showed that RS, in combination with Partial Least-Squares Discriminant Analysis (PLS-DA), can differentiate between various stages of infection with *Borrelia* in mouse blood. We also found that our innovative approach can differentiate between healthy and infected mice, as well as between the PGAU strain of *B. afzelii* and the PBI strain of *B. garinii*. Thus, this approach has strain specificity in pathogen diagnostics. These results demonstrate that RS in combination with PLS-DA may transform clinical approaches for pathogen diagnostics in the nearest future enabling inexpensive, non-invasive, non-destructive screening for LD and other bacterial infections.

Subjects: Health and Medicine (STEM), Science (STEM)

Utilizing Computer Vision and Sensor Fusion for Autonomous Vehicles

Abdelwahid Eltayeb, Abd-Allah El-Attar, and Ahmad Al-Khateeb

Faculty Advisor: Hussein Alnuweiri, Ph.D.

Thousands of people are either killed or left with disabilities annually due to road traffic accidents, most of which are due to human error or sensor failures. Despite that, a lot of people seem reluctant to look into alternatives to manually driven vehicle transportation. This is understandable as driving cars has been the trustworthy mode of transportation for many years, and it is widely used in everyday life around the world. However, technological advances in the fields of machine learning and cyber physical systems contributed to the emergence of nearly or fully autonomous vehicles, or driverless cars as a true viable alternative for the current human controlled driving mode. The technology still has a long way to go, especially because the advances in vision and depth measurement sensors such as Lidars, can not achieve the levels of safety needed to make fully autonomous cars. Progress on this front is being made every day, and it seems inevitable that they will be readily available in the near future. The aim of our team is to further investigate the application of Computer Vision and sensor fusion to achieve independent self-driving without external guides. To accomplish this, we're combining a depth camera with a LiDAR to provide better coverage of the surroundings and allow more accurate detection and avoidance of obstacles. We are mounting the vision system on a model driverless car, and using the vision data to guide the car control system. A computer vision algorithm will be run by the NVIDIA Jetson Nano to determine what course of action the car should take. The final prototype should be capable of driving at a reasonable speed without colliding with any objects and making decisions such as braking or turning when necessary.

Subjects: Engineering (STEM), Technology (STEM)

Wavelet-Based Spectrum Hearing Test and Equalizing Hearing Aid

Lauren Williams

Faculty Advisor: Oscar Moreira-Tamayo, Ph.D.

This project consists of two parts: the design of a test to better map frequency response of a user's hearing; and the construction of a device to process the results of that test into equalized soundwaves. We have designed the test using wavelets as opposed to pulses or sinusoids, with the hypothesis that wavelets (which generate fewer high frequency characteristics) will allow for a more accurate hearing test. The test is ultimately intended to electronically program the equalizer of a hearing aid. The equalizer is the only part of the hearing aid that will be designed in the scope of the project. It will use programmable potentiometer integrated circuits to adjust the levels of different frequency ranges. The hearing test will be validated according to: its spectral outputs; its comparison to existing literature; and its results when compared to a sinusoid-based hearing test. Results have yet to be determined, but we expect to find that using wavelets in the hearing test will reduce confusion among the test takers and produce moderately more accurate results, especially among test takers who do not have a trained ear. The significance of this research is twofold: the wavelet-based test, if found to be effective, should replace sinusoids as the standard hearing test; and the self-tuning hearing aid would make an improvement in quality of life, should this inspire a marketable product. The test can potentially be programmed into an app, such that the intended user could assess the frequency response of their own ears and update the tuning of their hearing aids without frequent, expensive trips to an audiologist. Such technology is not on the market but could improve quality of life for those who cannot afford uniquely tuned hearing aids.

Subjects: Engineering (STEM)

Whole Body Vibration Platforms and Their Effect on the Equine Body

Emily Read

Faculty Advisor: Chelsie Huseman, Ph.D.

Whole body vibration platforms are commonly utilized across the equine industry. However, very little research has been done to quantify vibration transmission to multiple tissues across the equine body. Limited research in the horse has largely focused on examining the platforms' impact on physiological aspects, such as bone density, muscle stimulations, and rehabilitation of lameness. However, most reports exclude crucial information about vibration platforms and transmission that makes comparisons across studies near impossible. The initial work of this study quantified vibration transmission at the hoof of both a front and hind leg, cannon bone, withers, and croup while using a TheraPlate (Weatherford, Texas) vibration platform. This work establishes normative values for transmission to various tissues from the platform and creates the opportunity to compare previous studies more accurately and evaluate clinical merit. Therefore, this project has the potential to change how further investigations are completed and reported, and ultimately, how vibration platforms are utilized across the equine industry. Expected outcomes of this project are to establish values for transmitted amplitude of acceleration and frequency values throughout various portions of average, healthy horses. The subject matter of vibration platforms is an important object of scholarly inquiry due to the variation and incomplete foundation in previous studies, the broad industry impacts of this project, and the capability to revitalize previous projects' results and to compare data to future results as well.

Subjects: Science (STEM)

Writing TriPoll in GraphBLAS

Abeer Waheed

Faculty Advisor: Tim Davis, Ph.D.

Making Graph algorithms as fast as possible in as little time as possible is a key goal for many data scientists. To this end, GraphBLAS was built. GraphBLAS is a standard that defines using linear algebra to solve Graph problems by defining a set of sparse matrix operations on semirings with different operators. Applying these semirings to sparse adjacency matrices work similar to traditional Graph computations. This framework allows Graph Algorithms to leverage existing parallel techniques found in the much more researched and older field of linear algebra, allowing for fast development times with strong performance. Using SuiteSparse:GraphBLAS (which is an implementation of the GraphBLAS standard), a GraphBLAS implementation of the TriPoll algorithm is built, and the process and results are examined. TriPoll is an algorithm that is capable of surveying triangles (3-cycles) in Graphs with metadata on them. It was chosen to be implemented in GraphBLAS as it was recently published, has useful functionality, and is relevant.

Subjects: Engineering (STEM), Mathematics (STEM)

Zumba's Effects of Stress Levels

Sloane Savoini

Faculty Advisor: Alexandra Pooley, MFA

Movement of the body has always been a large part of an individual's life. Basic locomotor movements such as walking, playing basketball to showing steers. College students, stress levels elevate during certain times of the year. Finals is a prime time for their stress levels to be high. This research begins right as stress levels begin to peak. This study was conducted the day before finals and during the first day of finals at Texas A&M University. A certified Zumba instructor came for two days and taught a 45-minute-long class on each day. The participants completed a survey before the class and immediately after they had finished the Zumba class. After both classes had finished and the responses were collected, the study shows that this type of aerobics class influences college students' stress levels. It influences stress levels in a positive way. 88% of the responses said that their stress levels decreased and that the participants would take another Zumba class in the future. This study can further to help encourage college students to take time out of their busy schedule to participate in a form of exercise. For this study, Zumba was utilized, however that doesn't always have to be the activity of choice. Including playing a basketball game, jogging, or taking a yoga class. The reason for this study is to show students that taking a mental break and engaging in some type of activity will help lower their stress levels and potentially help perform better on their exams or projects.

Subjects: Health and Medicine (STEM)