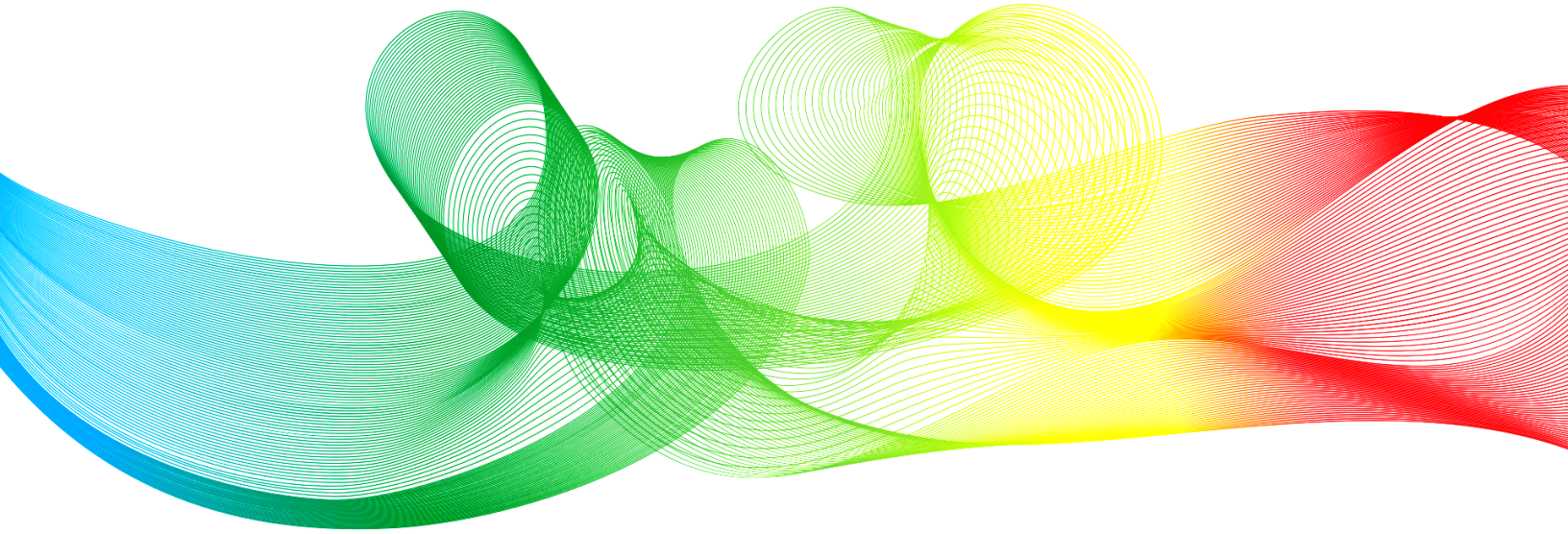
Science, Mathematics & Computing Division

Senior Project Poster Session



Spring 2022

An Exploration of Electric Vehicles

Oliver P. Allen
Advisor: Paul Cadden-Zimansky

The SPROJ will be an investigation into what it takes to build an electric vehicle, from design to engineering to manufacturing. In the past couple years especially, companies have developed their own electric vehicles in search of an environmentally friendly and energy efficient way of using our Earth's resources. This project aims to produce a greater understanding of what this development entails. The main ideas were to develop a design that would be the blueprint for the vehicle, look into the physical properties of the materials and create an efficient power conversion from motor to wheels. The process and organization of this project clarifies how the development of electric vehicles today needs the collaboration of companies, utilizing their research and aspirations to achieve optimal output of power and energy efficiency using current technologies.

Constructing Positive Masculinities: Study Proposal for a Primary IPV Prevention Program through a Gender Focused Arts Intervention on Masculine Discrepancy Stressed School Aged Boys

Rachel Boyd
Advisor: Elena Kim

Intimate Partner Violence (IPV) is a global public health issue and human rights crisis. Preventative interventions focused on perpetrators of IPV are still under researched, and empirically-based interventions to address the global health crisis of gender-based violence are needed. This study proposes a 12-week gender-focused art intervention program as a solution to reduce IPV perpetration. This intervention is proposed to reduce masculine discrepancy stress (MDS), a predictor of IPV perpetration in boys aged nine to ten years and thus decrease the likelihood of IPV perpetration in adolescence. Additionally, this study serves as a preliminary analysis of the constructs mediating the relationship between MDS and IPV. By comparing the intervention condition, recess condition, and control condition, six research questions will be investigated: (1) Do boys as young as nine or ten experience MDS? (2) Does Vilkin et al.'s (2020) gender-focused art program serve as an effective intervention in reducing MDS? (3) Can school-based gender-expansive interventions reduce the likelihood IPV perpetration? (4) Is there a social spillover effect of gender-expansive intervention on boys who are in the recess condition? (5) Does Vilkin et al.'s (2020) gender-focused art program reduce MDS and IPV-related factors through social and emotional learning? (6) Lastly, what is the relationship between MDS and IPV-related factors, specifically impulsivity and emotional regulation? My proposed study will add to the burgeoning research supporting MDS as a viable construct to target for IPV intervention. My study will offer a path to a potential solution to the public health crisis of IPV in the United States and contribute to the understanding of primary IPV preventions globally.

Interval Driven Melodic Mutation Using A Genetic Algorithm

Jack Carson
Advisor: Robert McGrail

This work presents a genetic algorithm in which melodies evolve according to levels of consonance. A user inputs a melody that over many iterations is mutated to be made up of new notes. Notes are only changed if they better match a level of consonance decided by the user. The larger the distances between notes are in the melody, the better the program is able to perform.

Are Harvester Ants the Tick Predators We Thought They Were?

Brit Chapman
Advisor: Felicia Keesing

Ticks are a global problem for humans, as they are vectors of diseases that affect both human and livestock health. In the eastern United States, black-legged ticks (*Ixodes scapularis*) are the vector of the bacterium *Borrelia burgdorferi*, the agent which causes Lyme disease. Despite their importance in regards to human health, few predators of black-legged ticks have been identified. Despite a lack of evidence, the harvester ant *P. barbatus* and many other ant species have been thought to consume ticks. Ants are important as both invasive and keystone species, with widely-ranging impacts on the environments they live in and tick abundance. However, the relationship between ants and ticks is often understudied, with many species simply presumed to lower tick numbers via predation. Certain species of harvester ants of the genus *Pogonomyrmex* have been considered tick predators, even though evidence for this is lacking. In order to understand the relationship between *Pogonomyrmex* ants and black-legged ticks, I have conducted a series of feeding trials with mixed colonies of *P. barbatus* and *P. badius* in order to compare ant interaction and feeding behavior between I. scapularis and other food items. Over the course of these feeding trials, the harvester ant colonies never injured, killed, or consumed any black-legged ticks.

Sustainable Energy Imaginaries:
Utilizing Mie Optics to Reengineer Photobioreactors and Reimagine the Socio-spatial Conditions of Autonomous Energy Production

Spencer M. Checkoway
Advisors: Antonios Kontos & Ross Exo Adams

In order to build a more sustainable future, society must transition toward carbon negative energy production and infrastructure. Algae photobioreactors have proven to be an efficient producer of lipid rich oil which can be synthesized into carbon neutral biodiesel. However, the neutrality of such a technology rests in its ability to yield adequate algal biomass through photosynthesis. In order to reach maximum quantum efficiency of algal cells, solar flux must be transformed so that photon absorption can occur without oversaturating the constituent matter. This project looks at the scattering effects of iridocyte-like structures and their potential to create cost effective solar transformers by utilizing the principles of geometrical optics, spherical harmonics, and Mie theory. Additionally, the socioeconomic implications of energy autonomy are considered across communal scales, along with a reimagining of the socio-spatial arrangements behind decentralized energy production. In this way, the project serves as a model of multidisciplinary collaboration and the importance of use value in technological analysis–both of which will prove vital as we reorganize grid infrastructures to accommodate renewable energy.

Errors in Healthcare:
A Proposed Study Investigating a Universal Methodology for Improving Patient Handoffs and Limiting Healthcare Errors

Olivia Couture
Advisors: Justin Hulbert, Brooke Jude & Elena Kim

Medical errors are greatly considered to be one of the leading causes of death in the United States, with around 250,000 deaths occurring per year (Anderson & Abrahamson, 2017). Many studies have investigated the causes of these errors, and have found communication to be a major source. The present proposal is a two-study design first planned to investigate the effects of interruptions on the time taken to return to the Tower of London Task. This methodology has first been observed in Hodgetts and Jones (2006) who investigated this using undergraduate students as participants, and found a main effect of both duration and complexity of interruptions. This replication will use registered nurses to complete the London Tower Task while unexpected interruptions occur, attempting to see if these findings replicate. With those expectations, I go on to propose a follow-up study designed to test the effectiveness of an intervention to better handle such interruptions in the healthcare environment. The implementation of the I-PASS mnemonic has proven to be successful in minimizing healthcare errors by 23% in pediatric residency hospitals (Starmer et al., 2014). This proposal will not only replicate this methodology in other residency hospitals but the use of an I-PASS written template will be used to improve this methodology. The implementation of the I-PASS mnemonic and template will help to manage the intrinsic load of nurses during patient handoffs, by increasing their working memory capacity. This implementation will universalize patient handoffs within the healthcare system, and in turn, minimize the occurrence of health care errors and the death that come from it.

Identifying The Relationship Between Page Content and Title

Yabo Detchou
Advisor: Sven Anderson

This project seeks to find the similarity score between content on the page and title using cosine similarity from a word2vec model. Frequent words and randomly chosen words from each article were analyzed and compared against the title using three samples. Frequent words were found to have a higher similarity score with the title than random words. Word frequency helps you identify the most relevant keyword on the page. The bigger goal of the project is to develop a keyword suggestion tool. Identifying which keywords are most relevant in writing content is the first step.

Inhibition of *Batrachochytrium dendrobatidis* growth and development by novel bacterial strains from the skin microbiota of *Lithobates sylvaticus*

Alex Doolittle
Advisor: Brooke Jude

Batrachochytrium dendrobatidis is a fungal pathogen to amphibians which has been responsible for the decline of an estimated 500 different amphibian species globally. With the inevitable spread of chytrid to new communities of amphibians, current efforts are focusing on finding potential therapeutics for *Bd*, either on the individual or community level. One such strategy being explored is the use of novel microbes from the environment with innate defenses which allow them to inhibit the growth and development of *Bd*. The secondary metabolite produced by bacteria which has been of interest in the exploration of this branch of therapeutics is the pigment violacein. In this study, native bacteria are swabbed from the skin of Lithobates in search for violacein producing bacterial strains. The bacteria which produce violacein are isolated and then assayed against *Bd* in order to see whether they inhibit its growth and development at different life stages. The strains which successfully inhibit *Bd* are then identified down to the species or genus using genomics, then further characterized using sequencing data and imaging via microscopy.

Investigating the Influence of Age on the Incidence of Mechanical Complications in Adult Spinal Deformity Surgery

Anielka Espinosa
Advisor: Gabriel Perron

Adult spinal deformity (ASD) is a complex diagnosis that covers a range of spine-related diseases or natural deterioration with aging that can cause deviation from normal curvature. Clinicians may surgically correct ASD to improve alignment, provide better functional outcomes as well as reduce disability and pain. However, while some strategies do consider age in their realignment goals, it is not clear how age influences mechanical complications, which are related to the implant. Here, we compared patients that differed in their age (either older or younger) and initial spinal deformity (either high or low deformity) to evaluate if age explained differences in mechanical complication rates. We also identified predictors of any and major mechanical complications in each group. Using some of the predictors that were identified and other important health indicators, we built models to predict mechanical complications in every group. We found that there were no significant predictors of minor mechanical complications, but there were different predictors for major mechanical complications in every group. Interestingly, we also observed that every patient that was fixated to their pelvis during surgery also had a major mechanical complication, regardless of their age or initial deformity. The models we built also consisted of different health indicators, suggesting that age should be considered when evaluating mechanical complications.

Eww vs. Taboo: The Effect of Physical Contamination and Moral Transgressions on Feelings of Mental Contamination

Katie Fallon
Advisors: Justin Dainer-Best & Richard Lopez

Mental contamination is a concept that has gained empirical support over the last few years. Feelings of dirtiness have arisen from not only being the victim of unwanted contact, but also being the imagined perpetrator of it, which threatens one's own morality. No studies have explored if moral transgressions alone can provoke feelings of mental contamination. The aim of this study was to explore if both physical contamination and moral transgressions can evoke symptoms of mental contamination. Additionally, the study tried to identify if a relationship between Obsessive-Compulsive Disorder (OCD) symptom severity and feelings of mental contamination existed. Participants read one of three vignettes: physical contact with a disgusting object, being the perpetrator of an immoral act, or a neutral walk around the neighborhood. Feelings of contamination were assessed at baseline and after reading the vignettes in an online sample of adults (N = 112). Use of neutralization strategies were reported to see if a non-clinical sample would counteract aversive material. The results indicated that physical contamination is more effective than moral transgression at evoking feelings of mental contamination. In addition, there was no relationship between OCD severity and greater feelings of mental contamination except for disgust. Physical sensations such as cleanliness and dirtiness seemed to be more affected by the physical contamination condition while emotional states such as disgust were able to be influenced by a moral transgression. Additionally, it appears that mental contamination may not exclusively affect those who show greater intensity of OCD symptoms.

Fire Retardant: Friend or Foe?
How Fire Retardant Effects Growth and Germination Rates in C-Ferns

Erynn Frost
Advisor: Felicia Keesing

Although California has a long history of wildfire, recent factors such as climate change and population growth have put the state in danger of increasingly intense fire seasons. This extreme fire risk has led to the dropping of millions of gallons of fire retardant on California forests, with the specifics of the environmental impacts of doing so still largely unknown. Using c-ferns (*Ceratopteris richardii*) as a model, this study tests how the presence of various concentrations of fire retardant affects germination and growth. It was found that while low concentrations of retardant have little effect on germination rates, higher concentrations can either reduce germination rates or prevent it entirely. Additionally, all c-fern spores that germinated in the presence of any level of fire retardant grew into gametophytes that were at least four times smaller than control gametophytes. The reduction of long-term fire retardant use and the reintroduction of Indigenous fire prevention techniques could be the answer to these deleterious environmental impacts.

Does Music Percussion Has Impact on the Selective Attention of College Students?

Lyra Fu
Advisor: Justin Hulbert

Previous studies indicate that fast or high-pitched music has a negative effect on people's attention. However, some kinds of music could improve study efficiency. This study compared how pulse and sound frequency affect the selective attention of college students. Forty-two Bard College students, aged from 18-24, participated in this study.

Four groups of participants listened to background music that shared the same melody line but differed on the dimensions of pulse (every half notes vs. Every quarter notes) and frequency (about 580Hz vs. 43Hz) as they completed the d2 test of selective attention. The effect of music on selective attention was analyzed.

Due to the small sample size, there was not a statistically significant result. Based on the fact that there was not a result, future study will need to be pursued.

Tripping over Trauma: A Proposal of Psilocybin-assisted Therapy for Comorbid Post-traumatic Stress Disorder and Depression

Liam Gomez
Advisor: Kristin Lane

Post-traumatic Stress Disorder (PTSD) is a widespread, often debilitating affliction that is only partially attenuated by current first-line treatment despite its heightened prominence in the sociopolitical arena. Since individuals with PTSD also experience high rates of depression comorbidity and resultant suicidality, it is essential that treatment is more holistically effective. A possible novel intervention, psilocybin-assisted therapy, has shown promising results for the improvement of depression, addiction, and other disorders; prospectively, when administered with non-directive therapy, it could prove to be an efficacious intervention for PTSD with comorbid depression. In the proposed study, there will be two participant groupings: the control group - low-dose psilocybin - and the treatment group - high-dose psilocybin. Over the span of about two months with an additional six-month follow-up, participants will undergo two increasingly scaled dosing sessions in low or high dosage groups and, throughout, will be measured for PTSD and depression symptom severity. Participants will be measured using the Clinician Administered PTSD Scale for the DSM-5 (CAPS-5) and Beck-Depression Inventory II (BDI-II) as primary measures for PTSD and depression. Outcome measures will be taken at baseline, before and after both dosing sessions, at the end of the two-month study period, and at six-month follow-up. A *t*-test will be conducted to measure any significant differences in symptom scores between the two participant groupings.

Fourth-Dimensional Education in Virtual Reality

Jesse Hamlin-Navias
Advisor: Keith O'Hara

This project was driven by an interest in mathematics, visualization, and the budding field of virtual reality. The project aimed to create virtual reality software to allow users to interact and play with three-dimensional representations of four-dimensional objects. The chosen representation was a perspective projection. Much like three-dimensional shapes cast two-dimensional shadows, four-dimensional shapes cast three-dimensional shadows. Users of the software developed in this project could interact and experiment with these three-dimensional shadows using hand controlled inputs. The hypothesis put forward is that virtual reality is currently the best medium to teach three-dimensional and four-dimensional geometry.

The Effects of Divorce on Middle-Childhood and Adolescent Cognitive Development

Emma Stewart Heffron
Advisor: Sarah Dunphy-Lelii

Divorce is extremely common in the United States, we hold one of the highest divorce rates in the world. With this being said it can be understood that many children are caught in the middle of a divorce. Current research has looked at the difference between low conflict and high conflict divorces and the effects they may have on children, which is shown to only differ slightly. In this paper I will be looking at the effect divorce has on a child depending on their stage in development. By looking at Piaget's Developmental Stage Theory, I am able to dissect the developmental focus as well as internal crisis in order to analyze the struggles the child may have in the future. This study will entail surveying individuals 18 to 35 and asking them questions about their current state as well as their parents style of parenting, mental and educational abilities, as well as their abilities to maintain relationships after experiencing their parents divorce. By looking at this data we will be able to see that each stage of development causes a different struggle, or outcome, for the child because of the dysfunction and disequilibrium caused by the divorce of their parents.

Color Me Impressed:
Using Lexical Decision Task to Understand Color-Word Associations

Freddie Hernandez
Advisor: Thomas Hutcheon

Color Psychology is defined as "the study of how various hues, or colors, affect people and their behavior". (Ungvarsky, J. 2021) Colors extend past everyday life, when used properly, can greatly influence our behavior. Evidence supports that color is associated with emotions and emotion-laden words. This study tests whether colors would activate food related or optimistic thoughts. In this study, utilizing the Lexical Decision Task, participants were asked if words were in fact words or nonwords, after being primed with one of three colors: red, yellow or gray. It was hypothesized that when primed with red, participants would identify a food-related word as a word faster than in other colors. And that when primed with yellow, participants would identify an optimism-related word as a word faster than in other colors. My findings did not support this hypothesis, but did provide further evidence in the role of varying color and how that can influence behavior, response time. Additionally, the automatedness of these color word-associations are discussed and what can be done to understand these relationships.

Kinetic Characterization of PP0763: A Protein Involved in the Production of Poly[(R)-3-hydroxyalkanoates] (PHA's)

Nataniel Janer Pagan
Advisor: Swapan Jain

Poly[(*R*)-3-hydroxyalkanoates] (PHAs) are biodegradable polymeric materials synthesized by gram negative bacteria from sugars or fatty acid carbon feedstocks. PHAs are produced by microorganisms when they are grown under nutrient limiting conditions with an excess of carbon sources. These high amounts of carbon feedstocks get converted into PHAs with the purpose of providing the microorganisms with a carbon reserve. The PHAs get packaged into granules that can be harvested by scientists to make a grand variety of products. Among the most innovative uses for PHAs are their biomedical applications that include sutures, drug delivery capsules and tissue engineering of heart valves. These materials do not require photochemical nor mechanical processes for degradation, they get broken down by other microorganisms and enzymes to carbon dioxide and water. Our contribution relates to the role of PP0763 in the metabolic network pertaining to the conversion of fatty acids into PHAs present in the gram negative soil bacterium *Pseudomonas putida* KT2440. This protein is hypothesized to have 3-hydroxyacyl-CoA ligase activity responsible for the synthesis of the 3-hydroxyacyl-CoA PHA precursor. Here we report our efforts in elucidating the substrate specificities of PP0763 by employing the DTNB colorimetric assay to measure the kinetics of fatty acyl-CoA synthesis in the presence of fatty acids of varying chain lengths and chemical compositions.

Phage Hunting on the Campus of Bard College

Christina Kiser
Advisor: Brooke Jude

Antibiotic resistance poses a major threat to global public health. Due to the increased number of bacterial pathogens becoming multidrug and extensively drug resistant, as well as antibiotic resistance to nearly all developed antibiotics, investigation of alternative methods for treating bacterial infections have been ongoing. Phage therapy is a viable option to combating antibiotic resistant bacteria in a clinical setting, however, its application is stunted by a lack of host-specific bacteriophages. In order to help alleviate this barrier, phage hunting was conducted on the campus of Bard College in search of bacteriophages against the host *Mycobacterium abscessus*, which serves as a good model for *Mycobacterium tuberculosis*. Bacteriophages were not successfully isolated from three different soil collection sites using three different isolation methods. Increased participation and continuous phage hunting must be conducted in order to advance phage therapy and its ability to treat antibiotic resistant bacterial infections.

¿Quién soy yo? [Who am I?]: Exploring Identity through Analyzing Afro-Cuban Poetry and Creative Coding in a Post-Secondary Spanish Literature Classroom

Megumi Kivuva
Advisors: Keith O'Hara & Sven Anderson

With efforts to broaden participation in computing by integrating CS education into humanities and developing more critical pedagogy, this research focuses on teaching computing in a post-secondary Spanish literature class through analyzing Afro-Cuban poetry. Its goal was to evaluate how participants may use Twine to reflect on Afro-Cuban poetry and their own identities. A group of 5 participants, one professor, and four students, learned how to use Twine to create interactive narratives reflecting on "El apellido," a poem by Afro-Cuban poet Nicolás Guillén. Through analyzing researcher notes, participants' projects, post-workshop surveys, and interviews, the research revealed that students were able to engage with themes of identity through poetic analysis using Twine. Participants integrated their own identities into their projects, while also engaging with the literary themes of the poem. The experiences of the professor and a reluctant student are also highlighted in this work. This research shows how Twine can be used as a creative pedagogical tool to teach students computing, analyze poetry using digital literacy methodologies, and empower them to think critically about their own identities.

An Analysis of Long-Term Financial Feasibility of Higher Education

Jacqueline Lerman
Advisor: Kerri-Ann Norton

This project explores the long-term financial feasibility of higher education. With rising costs of higher education and so many choices surrounding a degree such as degree type, sector of institution one attends, student loans one takes out, and field of study, it can be hard to discover which path will be most profitable long-term. This project analyzes data from the National Center of Education Statistics to see if there are existing relationships between these variables that contribute to different experiences in higher education and financial outcomes, specifically relating to future income and student loan payments. To do this I use various statistical tools and models such as multiple linear regression, tests for correlation, Kmeans clustering, and ANOVA testing. While most of these tests showed little or no relationship or significance, through clustering I found that those who get both an associate's and a bachelor's in the same field, make on average significantly more than those who get an associate's and bachelor's degrees in different fields. I also start the creation of a summary statistics interface with the intent to display data in a way that those with minimal scientific background could understand in the hopes that this project will continue to spark conversations around the inaccessibility of data surrounding higher education and the realistic outcomes that different paths through higher education will provide.

Prehistoric Populations: Determining the Age-old Numbers of *Albertosaurus sarcophagus* Across the Continent of North America

Sivan Levi
Advisor: Felicia Keesing

When it comes to prehistoric life, there's generally not a lot to say or look into in terms of the population size and density. Dinosaurs are extremely tricky in this regard, as not only are the fossils rare, but determining age, gender, and even specific species is difficult with all the new discoveries all over the world. Fortunately, paleontologists use modern animal survival curves and other factors to determine the population of an animal in a generation in a specific home range. Known animals like white-tailed deer, Dall's sheep and others have had extensive research done on them and biologists have used this data to monitor population growth and decline in animals still around today. Using such data from living animals, dinosaurs like *Tyrannosaurus rex* can have their populations estimated by looking at how many animals are found in an area, how many of each age group are present, the animal's survival rate, generation time and a species' temporal range. Not many studies have been conducted on this, but *Albertosaurus* has had as much, if not more data collected about it and its range as its close relative and figures to be another subject for estimating how many of this dinosaur species was around 75 million years ago.

Harmony in Memory:
A Program to Help Harmonize a Classical Melody

Alexander Levinson
Advisor: Kerri-Ann Norton

Harmony plays a crucial role in classical music: supporting the melody. There are, however, so many different ways to harmonize one melody that one person may not even consider them all. I developed a program in Python 2.7 which would intake a melody of notes, for example in the form of "C, D, E, C", and return all possible harmonizations to that melody (excluding some more complicated harmonic cases that are not yet implemented into the program). The first draft of the program that was made was clearly optimizable, leading to two versions of the programs being made: the "unoptimized" and "optimized" programs. Comparing runtimes and memory consumption of these programs showed that while the optimized program was always predicted to be faster than the unoptimized one, for larger and larger melody inputs, the unoptimized program actually used less memory than the optimized one.

Analysis of Platinum Based Drugs Binding with sgRNA in CRISPR-SpyCas9 Assay

Jingzai Li
Advisor: Swapan Jain

Clustered Regularly Interspaced Palindromic Repeats (CRISPR) is a revolutionary gene-editing tool which utilizes a sgRNA and Cas9 enzyme to precisely target and cut a specific region on a DNA strand. In recent years, the popularity of the CRISPR system has grown exponentially, with thousands of papers on the popular gene-editing system published every year. Alongside the emergence of CRISPR, is the rising awareness of the practicality and importance of RNA. New studies on RNA are being conducted at a rate higher than ever, and among them is the study of RNA binding with chemotherapy drugs. In this study, Cisplatin, Oxaliplatin and Carboplatin are used to investigate the effect it has on the CRISPR-Cas9 system when bound to RNA. By incubating sgRNA with these platinum drugs and column purifying it, a sgRNA-drug complex can be made. Using this complex, a Cas9 experiment is run and results analyzed using gel electrophoresis. Analysis shows that by binding Cisplatin or Oxaliplatin to sgRNA, the amount of DNA cleavage is inversely proportional to the concentration of Cisplatin, while the presence of Carboplatin yields no changes.

Listening With Lasers:
A Novel Interferometer Microphone

Balthazar Loglia
Advisor: Antonios Kontos

Interferometry is a technique which uses the interference of electromagnetic waves, such as visible light, to extract information from the paths that the waves have traversed. In a Michelson Interferometer, this technique is achieved with a laser source which is split into two equal parts and then recombined to measure the relative difference in distance between the two respective beams. Building off of this standard design, this project presents a novel laser interferometer specifically setup to measure the acoustic vibrations of a reflective surface. The goal of this interferometer microphone is to accurately record sounds with the use of a specialized mirror, designed to act as an acoustic diaphragm that vibrates mechanically in response to varying air pressure due to sound waves. To achieve this goal, an electronic feedback loop is utilized to lock the interferometer in order to suppress seismic noise and prevent signal loss. The finalized design of the setup is meant to be used as a guide for anyone who wishes to measure signals of their own through the use of interferometry.

Extraction of Local Herbs for Alternative Contraceptives

Gabrielle Gonzales Martinez
Advisor: Emily McLaughlin

Herbs have aided us throughout our existence and serve as the foundation for pharmaceutical advancements. Herbs are used throughout our daily lives to consistently serve us. Queen Anne's Lace is the herb that is investigated in this project. Also known as wild carrot, this plant has been cultivated by midwives, herbalists and scientists alike to discover more of what it has to offer. For this project, a particular focus is on the presence of anti-fertility secondary metabolites of this wild carrot. There are six active small molecules called polyphenols claimed to found within this plant, catechin, epicatechin, eriodictyol, cyanidin, peonidin and pelargonidin, and we aim to achieve evidence of them throughout this research. Computational research on these polyphenols proposes that these molecules may contribute to the anti-fertility activity of the plant. A study of extractions from this plant and other wild carrot tinctures is presented along with chromatographic separation and analysis by nuclear magnetic resonance (NMR) spectroscopy.

The Effects of D2 Receptor Modulation on Locomotor Development in *Danio rerio*

Isaiah McRoberts
Advisor: Frank Scalzo

This study utilized a novel design to investigate the sensitivity of D2 dopamine receptors to modulating compounds through multiple exposures over early development of zebrafish larvae. Zebrafish were dosed for 30 minutes from 5-8 days post fertilization (dpf) with 16μ/mol of either a D2 antagonist, haloperidol, or a D2 agonist, quinpirole hydrochloride. Two other groups were then dosed with these compounds from 9-12dpf. The effects of D2 receptor modulation were measured by analyzing motor activity on measures of movement distance, frequency, and velocity. Results indicated that larvae dosed with haloperidol on 5dpf had increased activity after the first dosage, but these differences lessened over days 6-8dpf. While conversely, the quinpirole group displayed a decrease in movement activity during trials but in this case, there was a greater deviation from control on trials during 7 and 8dpf. These effects were not observed in subjects dosed from 9-12dpf, which displayed no significant differences from control activity, supporting the hypothesis that those dosed earlier in development would experience greater impacts of D2 modulation. Follow up testing at 16-18dpf did not result in statistically significant differences across treatments, but there were trends on all three measures of lower activity in the quinpirole 5-8dpf group and increased levels of activity in the haloperidol 5-8dpf group. Taken together, these results provide further support for use of *Danio rerio* larval locomotor activity as a measure of D2 receptor modulation as well as evidence for differential impacts on dopaminergic activity dependent upon the period of drug administration.

Synthesis and Characterization of Cyclometalated Ruthenium (II) Complexes and Assessment of Their Potential as Pharmaceuticals

Leslie A. Morales
Advisor: Craig Anderson

Cyclometalated Ruthenium (II) and RAPTA species were synthesized, characterized, and evaluated for their photophysical properties and potential as pharmaceutical agents. The binding affinity to yeast RNA of the newly synthesized compounds containing a thiophene group (LM5400, LM3000) was compared to its literature precursors (Compound B, Compound A) containing a phenyl group under gel electrophoresis. Results indicated that the bands of compounds; Compound A, LM3000, Compound B and LM5400 when incubated with yeast RNA for 24 hrs, were similar to the control with the exception of the band LM5400 being more faint. Photophysical experiments on cyclometalated ruthenium (II) compounds (Compound A, LM3000, Compound B, LM5400) indicated that these compounds have an absorbance around 345 nm - 360 nm respectively but do not fluoresce. Four hydrolysis studies were done on the cyclometalated ruthenium (II) species under various conditions and monitored via UV/Vis and H-NMR. Under all conditions, the absorbance and the NMR data the complexes with the n6-benzene ring (Compound B and LM5400) changed in both aqueous and chloride solutions. All compounds synthesized were characterized by NMR. Crystal structures were obtained for newly synthesized compounds, LM3000 and LM5400.

A Grant Proposal for the Effects of Autonomous Sensory Meridian Response on Sleep Quality in Older Adults

Julia Morin
Advisor: Justin Hulbert

Autonomous Sensory Meridian Response (ASMR), first coined by Jennifer Allen in 2010, is a term used to describe an automatic emotional and physiological response to certain auditory and visual stimuli. This sensory phenomenon is characterized by feelings of pleasure, calmness and a tingling sensation down the scalp and back (Poerio, 2020). What originally started out as a phenomenon some people experience in everyday life evolved into an internationally recognized and sought-after media made available on a variety of platforms including YouTube. ASMR's popularity may be attributed to its reported sleep, relaxation, and mood improvements in younger adults (Barratt and Davis, 2015). Sleep Disturbances are particularly prevalent in the elderly, especially amongst nursing home and assisted living facility residents. This is a growing concern considering how instrumental sleep is to daily functioning and the detrimental effects poor sleep can have on people's health. Poor sleep in older adults is associated with chronic stress, increased morbidity, and lower quality of life (MacLeod, S. et al. 2018).Taken together, this project hopes to explore the effects of ASMR on the sleep quality of older adults living in assisted living facilities, using younger adults as a comparison. The open questions I hope to explore in this study are: how do older adults who have little to no exposure to ASMR or preconceived notions about ASMR experience ASMR? Could ASMR experience and sensitivity be attributed to a placebo effect? Furthermore, how does ASMR experience change over one's lifetime? I plan on conducting a norming study in which participants aged 65 and up are presented with three ASMR videos and asked to provide feedback on the videos in a survey format. The results of the norming study will inform a grant proposal looking at the effects of ASMR vs. a control video on the sleep quality of residents of assisted living facilities and college students. Participants will be presented an ASMR and a control video before bed, and their sleep quality and ASMR experience will be measured using the Oura Ring Generation 3 and the ASMR-15. I predict there to be a significant effect of the ASMR video on the sleep quality and ASMR experience of younger adults. In addition, I predict there to be a significant effect of the control video on the sleep quality and ASMR experience of older adults.

An Examination of the Potential Use of Predatory Bacteria as a Co-therapy with Traditional Antibiotics to Treat Multidrug-Resistant Bacterial Pathogens

Tate Morrison
Advisor: Brooke Jude

The frequency of antibiotic resistance is rising exponentially across many bacterial pathogens and poses a major threat to current methods of infection treatment. The continuous use of diverse antimicrobial drugs has imposed selective pressure on many bacteria, causing their rate of mutation and resistance-acquisition to increase rapidly. Many bacterial pathogens are becoming multidrug-resistant and can be impossible to treat with traditional antibiotics. Antibiotic resistance is accelerated by the misuse and overuse of antibiotics, so alternative treatments to decrease or eliminate their use will be needed in order to combat infectious, highly resistant bacterial strains. *B. bacteriovorus* is a small, Gram-negative bacterium and an obligate predator of other Gram-negative bacteria. Prey resistance to *B. bacteriovorus* is quite rare due to its seemingly non-specific parasitic mechanism of infecting bacteria cells, replicating inside the host, and lysing its prey. However, *B. bacteriovorus* is not able to clear entire pathogen populations alone. A recent study of the efficacy of violacein and *B. bacteriovorus* treatments of multidrug-resistant Gram-negative and Gram-positive pathogens found that alone, the effectiveness of each antimicrobial agent was low, but when combined, the clearance of the pathogen was significantly higher. This study could be replicated with many other antibiotics and their multidrug-resistant bacterial targets alongside *B. bacteriovorus*. The purpose of this study was to establish a working infection of Gram-negative prey bacteria with *B. bacteriovorus* that could then be implemented in similar examinations of potential antibiotic co-therapies.

Comparing the Density of Different *Pseudomonas aeruginosa* Strains Between Standard Plate Count and Optical Density

Sadia Mustofa
Advisor: Gabriel Perron

Antibiotic resistance has emerged as a serious issue over the last 80 years, exacerbated by its overuse and misuse, and threatens the effective treatment of diseases caused by antimicrobials. As of 2020, the WHO reports the current antibiotic pipeline as "bleak," with the scarcity of new antibiotics; the primary concern is that the new antibiotics developed will not be enough to combat the current rise in antibiotic resistance. As new therapies are developed, it may be critical to look at preventative measures for antimicrobial resistance (AMR). That also includes a thorough understanding of the different pathogens, which are more susceptible to organisms, and whether their source of origin plays a role in their resistance. This study examines five strains of the pathogen *Pseudomonas aeruginosa* extracted from varying sources and determines whether their growth is identical or different. In particular, we compared the findings to the McFarland Standard and reevaluated whether this standard is an efficient way to standardize bacterial growth. We found that the growth of the strains varied, and strains PAO1 and Lw1047 contained the highest number of bacterial colonies. Also, we determined that the McFarland standard was efficient in standardizing bacteria as CFU/mL was reduced ten-fold by the McFarland but reduced the error represented by standard deviation. Future studies could examine the microbial growth against antibiotics or use in vivo testing with different infection pathways and see what concentrations of bacteria are most harmful in causing disease.

Predicting League of Legends Ranked Games Outcome

Ngoc Linh Chi Nguyen
Advisors: Kerri-Ann Norton & Sven Anderson

League of Legends (LoL) is the one of most popular multiplayer online battle arena (MOBA) games in the world. For LoL, the most competitive way to evaluate a player's skill level, below the professional Esports level, is competitive ranked games. These ranked games utilize a matchmaking system based on the player's ranks to form a fair team for each game. However, a rank game's outcome cannot necessarily be predicted using just players' ranks, there are a significant number of different variables impacting a rank game depending on how well each team plays. In this paper, I propose a method to predict rank game outcomes based on several different variables that would be collected 14 minutes into the games. Using three different machine learning algorithms: Logistic Regression, Random Forest, and Support Vector Machine, I found that game outcomes can be predicted with 79.46% accuracy with all the collected data and newly added variables. I also use the model to show the importance of each variable in helping players make winning decisions. The results show that the difference in gold between the two teams has the most impact on the final result of the games. The skill difference in the three groups can be further examined with extra variables that were not explored during the study.

Heroes, Villains, and the In-Between:
A Natural Language Processing Approach to Fairy Tales

Ruby Ostrow
Advisors: Sven Anderson & Keith O'Hara

While great strides have been made with natural language processing (NLP) techniques in the last few decades, there has been a notable lack of research into utilizing NLP for the genre of fiction. This project seeks to address this gap by considering the use of NLP techniques for the summarization of European fairy tales. This subgenre of fiction is an appropriate starting point for investigation due to its archetypal characters and relatively simple story arcs. My approach is to extract the main characters of texts, along with key descriptors in the form of modifying adjectives and verbal actions the characters take part in. Through this method, I suggest how we may parse characters into Proppian archetypes by tracking their probabilistic association with certain linguistic occurrences. This classification schema in turn makes possible the broader classification of fairy tales into types. The model has an overall F1 score of 0.77, the individual parts having F1 scores of 0.89, 0.75, and 0.66 for character retrieval, adjective extraction, and verb extraction, respectively. This project may also be extended further, laying key groundwork for further automatization of categorization of characters and ultimately stories themselves.

A New Way to Make Music: Processing Digital Audio in Virtual Reality

Gavin Payne
Advisors: Robert McGrail, Sven Anderson & Matt Sargent

The work of this project attempts to provide new methods of creating music with technology. The product, Fields, is a functional piece of virtual reality software, providing users an immersive and interactive set of tools used to build and design instruments in a modular manner. Each virtual tool is analogous to musical hardware such as guitar pedals, synthesizers, or samplers, and can be thought of as an effect or instrument on its own. Specific configurations of these virtual audio effects can then be played to produce music, and then even saved by the user to load up and play with at a later time. There are still goals to expand this project, and turn it into something more akin to a professional digital audio workstation, but for the time being it remains a modular synthesizer with nearly limitless configurations in a virtual 3D environment. Included is a developer library, giving users the ability to integrate their own musical software solutions into the virtual environment and expand the work of this project.

Wandering Wombs and Wandering Truths: How Physician Dismissal Impacts the Self-Trust of Patients with Endometriosis

Isabella Pihas
Advisor: Kristin Lane

"Oh don't worry these are normal cramps" "Have you been treated for anxiety?" "It's just everyday pain, there's no issue" These dismissive statements are too often said to patients with endometriosis, an often debilitating and painful disorder, when attempting to diagnose their condition. Whereas the existing research on physician dismissal focuses mostly on the medical system, this study aimed to understand the experience of dismissal from the patients point of view. Namely how does dismissal impact the way patients trust their physicians, but more importantly: themselves. The study employed a mixed-methodogy approach utilizing the Trust in Physician Scale (Anderson & Dedrick, 1990), the Rosenberg Self-Esteem Scale (Rosenberg, 1965), and an origional Self-Trust for the quantitative portion (N=10) and an interview protocol for the qualitative measure (N=1) to explore the emotional experience of dismissal and test the hypothesis that patients with endometriosis who had less trust in the physicians, thus rejecting physician dismissal, were likely to have higher levels of self-trust. Pearson correlation coefficient analyses found that patients with higher trust in physicians were likely to have higher trust in symptoms and higher self esteem as well as higher trust in symptoms indicated higher general self esteem. A multiple regressions analysis found a significant positive relationship between trust in self and physicians, trust in physicians and self-esteem; however not in the direction predicted by the hypothesis. This data contradicted by the qualitative data that explored how a patient was assigned blame instead of given a firm diagnosis and the ramifications of damaged trust following dismissal which suggests that dismissal may lead to lower self-trust and self-worth. These conflicting results draw importance to the issue of dismissal and prompt further research to explore the complexities of the relationship between self, doctor, and condition.

Using Mixed Reality to Better Develop Computational Thinking Skills in CS2

Samuel Rallis
Advisor: Keith O'Hara

Several concepts taught in CS2 relate strongly to abstractions and require students to conceptualize intangible theory. This alteration in thinking and learning style can prove difficult for those new to the discipline. To counteract this, this project is designed to aid teaching and learning through a projector-camera system. Using mixed reality allows learners better insight into how these abstract concepts are represented visually, while increasing engagement and interactivity. Additionally, the system aims to allow professors and tutors to devote more time to higher-level learning, while the essentials are practiced and drilled using a virtual tutor. The system uses tangible objects to represent array elements and local variables in rudimentary sorting algorithms. By engaging with the system, modifying inputs, and sorting tangible array elements, the user learns and strengthens the skills required to succeed in higher-level CS courses.

A Tale of Two Lakes:
An Analysis of Lake Optics and Their Effects on Turbulence

Guillermo Rode Viesca
Advisors: Antonios Kontos & Robyn Smyth

While the plants we see everyday have a stable and guaranteed source of light to photosynthesize, underwater plants do not have the same luxury. In stratified lakes there is only a slim region where microorganisms can receive the amount of light they need without being exposed to a harmful amount of heat. These lakes are structured vertically by temperature and density. The specific depths and densities of the layers are determined by the rate at which a lake absorbs light and turns it into heat. The layers determined by heat absorption then determine how materials which affect the water's optical properties (and thus its absorption rates) are distributed throughout the water. This darkening cycle threatens the stability of aquatic ecosystems by limiting the conditions in which microorganisms will thrive. In this thesis I compare data from two lakes with drastically different compositions to project the changes in the lakes' structures through time.

Establishing a Protocol of DNA Extraction to Investigate the Presence of *integron 1* in Air Samples

Nailea Rodriguez
Advisor: Gabriel Perron

Human health is widely influenced by a variety of factors including microorganisms present in built environments, i.e. homes and other enclosed public spaces. Most importantly, the abundance of bacteria pointing to antibiotic resistance has been exponentially increasing. Known contributors to antibiotic resistance bacteria (ARGs) include wastewater treatment plants, animal husbandries, and hospitals (Yang *et.al.*,2013). Studies done by *Ma 2017* and *Zhu 2017* demonstrated a strong correlation between ARGs and *int1* in natural and built environments. Due to this, we decided to develop and test a new methodology to collect and test air samples for ARGs. This new methodology was used to test the prevalence of *int1* genes in the air at the Bard College Kline Cafeteria throughout the day, on two different days. Samples were collected at three different times of the day: morning, afternoon, and night. Cq scores qPCR results were quantified into copy numbers. We found a higher prevalence of 16S rRNA genes, but there was no significant difference between *int1* and 16S rRNA genes ($F=0.22$, $P=0.81$; $F=0.22$, $P=0.81$) at different times of the day. Final results indicate the newly developed methodology has the potential to be used in future studies testing for ARGs in the air.

An Accessible Approach to Exploring Space through Augmented Reality

Eden Rorabaugh
Advisor: Keith O'Hara

Physically engaging with space is often difficult for people who struggle with mobility. Elderly people and people with disabilities in particular may find it challenging to walk for long periods of time on various terrain in order to explore their environment. This project is designed to provide an alternative way to physically engage with spaces without requiring the user to walk, and I am focusing on the accessibility of Bard's campus specifically. My project involves a map of the college that users can tour in an augmented reality environment. Through the use of a projector-camera system, this program projects a map and tracks objects placed on that map. It tells the user information about the space based on the object's location. Users are meant to collaboratively trace the map and label buildings as they explore them. Finally, users highlight their favorite locations with colored markers, and take a screenshot of the completed map. The colors used are associated with different subjective experiences of the campus and are projected back on the table in the final step of this project. This experience is meant to operate as an alternative to traditional physical tours while also maintaining the communal experience that Bard tours provide.

Metformin Containing Transition Metal Complexes: Synthesis, Characterization, and Binding Activity with RNA

Roxanne Rouskas
Advisor: Craig Anderson

Metformin hydrochloride, 1,1-dimethylbiguanide hydrochloride, is a diabetic medication that has been known to exhibit antimicrobial and anticancer properties. Metformin-containing transition metal complexes were synthesized and characterized by 1H NMR, IR and UV-Vis spectroscopy. The rate of hydrolysis of [Ru(η6-p-cymene)(met)Cl]Cl (Ru79) at room temperature in solution of water and PBS were investigated by UV-Vis and 1H NMR, suggesting that the NH2 of the metformin loses a proton after 24 hours which could explain its mechanism in cells. Assays of motility inhibition by these compounds with yeast RNA have been performed and showed the potential of the use of Ru79 as a treatment in RNA-centered diseases.

The Effects of Music-Induced Emotion on Memory

Jessica Rylander
Advisor: Thomas Hutcheon

Emotion can play a highly influential role when it comes to enhancing memory. Research has shown that emotional valence and emotional arousal are two key aspects of emotion responsible for facilitating this (APA, 2013). However, various studies have found contradicting results when it comes to which type of valence (positive or negative) and which level of arousal (high or low) have the greatest memory enhancing effects. Similarly, the majority of previous research has specifically investigated this emotion-memory relationship in terms of memory for emotional *content*. The present study aims to address this gap by separating emotion from the to-be-learned stimuli, instead investigating how one's emotional *state* while encoding *neutral* information, impacts memory for that information later on. After inducing specific emotional states via exposure to affectively-rated music, subjects were exposed to a video reel composed of various neutral clips of random scenes. Memory was then measured based on performance within a subsequently presented "yes"/ "no'' recognition task. Characterizing "conditions'' based on the four arousal-valence quadrants of Russell's circumplex model of emotion (1980): high arousal-positive valence, high arousal-negative valence, low arousal-positive valence, low arousal-negative valence, I predicted that, compared to the other groups, the subjects in the high arousal-negative valence condition would perform best on the memory task. Results did not support this hypothesis, yielding no significant differences in memory performance between the four conditions. The limitations of this study design are considered and suggestions are made for future research.

The Effects of Code-Switching on the Social Development of Bilingual Children with Autism Spectrum Disorder

Genesis Sandoval
Advisors: Justin Dainer-Best & Kristin Lane

Autism Spectrum Disorder (ASD) is a widely diagnosed developmental disability. There is a discrepancy between research showing that bilingualism and code-switching have no negative effect on language development in children with ASD and advice given by practitioners surrounding the adoption of bilingualism. Research shows that children who practice code-switching may benefit more than those who do not. This proposed study will examine the effect of code-switching on the social interactions of bilingual children with Autism Spectrum Disorder (ASD), specifically focusing on Hispanic children during ABA intervention.

Code-switching is the practice of alternating between two or more languages in conversation. In this proposed study, therapists will conduct therapy sessions with 102 children, ages eight to ten. Children will randomly be assigned into two conditions, one in which the trained ABA therapists code-switch at least five times per session and the others in which the therapists do not code-switch. The first and penultimate sessions will be recorded to measure the instances of code-switching. Social interactions will be measured by using the direct observational measure, the Behavioral Assessment of Social Interaction in Young Children (BASYC).

I hypothesize that children in the code-switching condition will also code-switch and have higher social interaction scores than the children in the control condition. If future results from this proposed study suggest that the proposed hypotheses are correct, it can help practitioners and parents make a decision regarding language use and possibly find a strategy to increase social communication in children with ASD.

Adderall Abuse Among College Students: Unveiling Underlying Motivations

Giordana Scanni
Advisor: Sarah Dunphy-Lelii

Adderall is the most common stimulant prescribed to individuals with Attention-Deficit Hyperactivity Disorder (ADHD). There is a growing body of evidence revealing how Adderall abuse is most commonly linked to academic enhancement. But there is limited research suggesting why Adderall abuse is still on the rise, and why it is so easily accessible despite its detrimental effects on the body. To assess this growing issue, the current study investigated whether doctors are properly monitoring the side effects of Adderall, while uncovering a potential underlying motivation of Adderall abuse for weight loss. This study identified a large sample of college students with and without a prescription for Adderall who I predicted were all at risk of abusing Adderall for weight loss (N=70). All participants were asked to complete a self-survey questionnaire which included questions from the adult ADHD self-report scale given as one of the predominant approaches in diagnosing ADHD in adults, measures of the participants' Adderall usage, and a measure of the individual's attitude toward eating. Results revealed that individuals with a script for Adderall scored higher on the ADHD self-report questions, and took Adderall more frequently than individuals without a prescription. While there was no significant relationship between individuals with or without a prescription for Adderall and uses for weight loss, 27.5% of the participants reported being satisfied with experiencing weight loss due to Adderall and six of those participants had a prescription for Adderall. Three of those participants had asked for an increase in their dose after noticing weight loss and four of those participants reported not telling anybody about their weight loss due to Adderall. I hope to shed light on the importance of receiving and acknowledging adequate and competent information towards Adderall to ensure doctors are prescribing Adderall for the proper reasons, and patients are more aware and informed of the harmful side effects.

Enforcing a More Complex Notion of Proper Posture with Pose Estimation

Marco Scanni
Advisor: Robert McGrail

Practicing poor posture for many hours throughout the day can lead to a myriad of both physical and mental morbidities. People tend to put their postures in jeopardy for multiple hours per day when using the computer. Pose estimation has the ability to track human positions in real-time with high accuracy and performance. The goal of this thesis is to provide evidence for what proper posture is, and enforce this proper posture through the use of a pose estimation model, namely BlazePose.

The Algebra of Type Unification

Verity James Scheel
Advisor: Robert McGrail

Type unification takes type inference a step further by allowing non-local flow of information. By exposing the algebraic structure of type unification, we obtain even more flexibility as well as clarity in the implementation. In particular, the main contribution is an explicit description of the arithmetic of universe levels and consistency of constraints of universe leves, with hints at how row types and general unification/subsumption can fit into the same framework of constraints. The compositional nature of the algebras involved ensure correctness and reduce arbitrariness: properties such as associativity mean that implementation details of type inference do not leak in error messages, for example. This project is a discovery and implementation of these ideas by extending the type theory of the Dhall programming language, with implementation in PureScript.

RGD Peptides, Integrins, and Cell Polarity in *Danio rerio* Mechanosensory Hair Cell Regeneration

Max Shapiro
Advisor: Michael Tibbetts

Human hair cells in the inner ear use delicate molecular machinery to detect and process pressure changes in the air which we understand as sound. These cells die when exposed to dangers including loud noise and aminoglycoside antibiotics. Humans cannot replace these cells, leading to gradual hearing loss with age. Some species retain the ability to regenerate hearing including the zebrafish *Danio rerio*. Exposed neuromasts across the body of zebrafish produce hair cells entirely homologous to those of the inner ear which the fish uses to detect motion in water. Zebrafish hair cells must orient themselves precisely during regeneration to transmit information about the direction of water movement to the brain. Regeneration in zebrafish involves active movement by hair cell progenitors to preserve this orientation. Hair cells require the core planar cell polarity pathway and Notch signaling to orient themselves. However, the mechanisms of cellular movement during regeneration remain unknown. Integrins are a family of transmembrane proteins that function in cell adhesion to the extracellular matrix (ECM) and in signal transduction. Integrins are implicated in epidermal stem cell differentiation and some forms of cell motility. A subset of the integrins contain the RGD binding motif which binds to the Arg-Gly-Asp peptide sequence to attach to the ECM. The goal of this study was to determine whether external application of RGD peptides to zebrafish could interfere with integrin binding and thereby test the importance of integrins to hair cell regeneration. Fluorescence imaging of hair cells exposed to labeled RGD peptides confirms that RGD peptides can enter the neuromast.

Hidden Symmetries of the Kepler Problem

Julia Kathryn Sheffler
Advisor: Harold Haggard

The orbits of planets can be described by solving Kepler's problem which considers the motion due to by gravity (or any inverse square force law). The solutions to Kepler's problem, for energies less than zero, are ellipses, with a few conserved quantities: energy, angular momentum and the Laplace-Runge-Lenz (LRL) vector. Each conserved quantity corresponds to symmetries of the system via Nöther's theorem. Energy conservation relates to time translations and angular momentum to three dimensional rotations. The symmetry related to the LRL vector is more difficult to visualize since it lives in phase space rather than configuration space. To understand the symmetry corresponding to the LRL vector, I use tools from Hamiltonian Mechanics, including the Poisson bracket, flow parameters, and action angle variables to make a visualization of the effect of the symmetry corresponding to the LRL vector. In particular the LRL vector corresponds to four-dimensional rotations in phase space. Though it is beyond the scope of this project I hope to use the solidified understanding of the relationship between conserved quantities and symmetries to simplify the derivation of the probability distribution of semi-major axis given a single direct image of an exoplanet.

Misophonia Severity and Emotional Dysregulation in a College Aged Population

Katri Shields
Advisor: Sarah Dunphy-Lelii

This study examines the relationship between the scores on the AMISOS-R (Amsterdam Misophonia Scale-Revised), a scale for misophonia activation and severity, and emotional dysregulation scores on the DERS (Difficulties in Emotion Regulation Scale), as experienced by young adults aged 18-23. The AMISOS-R is the most recent version of a clinical diagnostic criteria for misophonia. The DERS is a widely used measure for self reported emotional regulation, scored on 6 subcategories of emotional dysregulation allowing researchers an understanding of the experience as a whole. Participants in this study took a short survey that combined the AMISOS-R and the DERS, and all usable data was statistically analyzed and recorded using Qualtrics and Jamovi. High severity scores on the AMISOS-R positively correlated with both the overall emotional dysregulation score on the DERS, and nearly all DERS subcategories correlated with AMISOS-R severity levels with significant results.

Photophysical Studies of a 3D Printing Photoinitiator Excited by a 532 nm Laser

Tahmid Siddique
Advisor: Christopher LaFratta

Microfabrication using direct laser writing (DLW) is a very powerful microscale 3D printing technique that offers more complexity than the traditional means like μ-stereolithography. DLW using a continuous wave (CW) laser is not well explored or understood. In this work, the photophysics of DLW is explored using a 532 nm CW laser. The experimental methods include, 2-beam action initiation threshold method (2-BIT), fluorescence spectroscopy, absorbance spectroscopy and WebMO simulations. One crucial finding is the importance of polarization when performing the 2-BIT experiment, which deems some experimental results from the experiment to be unreliable. The 2-BIT results suggest a non linear order of absorption when microfabrication is done with a 532 CW laser, to be certain this experiment needs to be repeated with superior experimental design. The photophysical data suggest that the excited state of PI upon absorption possibly occurs via a singlet to triplet energy transition.

Haemonchus contortus Levamisole Resistance

Dawson Stone
Advisor: Michael Tibbetts

Haemonchus contortus, (Barber Pole Worm) is a deadly risk for ruminant livestock due to its lethal parasitic potential. The barber pole worm is a well studied model for the development of anthelmintic resistance. The barber pole worms develop levamisole resistance through genomic rearrangement of the acr8 to the acr8b allele contextualizing a test for the presence of the *acr8* and *acr8b* alleles using qPCR. Therefore, there is a need to analyze the correlations between specific farming practices and resistance developing to ensure the health of ruminant livestock. Four farms in Dutchess County NY were surveyed for history of levamisole resistance, and certain farming practices. Two sites at each farm were sampled, and the oocysts were isolated from each site. Two tests were carried out on these samples for the presence of: barber pole worms, and levamisole resistant or susceptible barber pole worms. To do these tests, the samples were divided into two batches for FITC fluorescent staining, and qPCR *acr8* and *acr8b* assays, which were consistent for the presence of barber pole worms for 7 out of 8 farm sample sites. The qPCR assays were carried out for the presence of levamisole susceptible *acr8* and resistant *acr8b* in control lab barber pole worm DNA samples, which showed no significant correlation between the resistant and susceptible alleles with the known levamisole resistance and susceptible control samples. These results provide ground for qPCR optimization, and the identification of a more consistent barber pole worm levamisole resistance genetic marker.

Does Bias Have Shape? An Examination of the Feasibility of Algorithmic Detection of Unfair Bias Using Topological Data Analysis

Ansel Tessier
Advisors: Caitlin Leverson & Robert McGrail

Artificial intelligence and machine learning systems are becoming ever more prevalent; at every turn these systems are asked to make decisions that have lasting impacts on peoples' lives. It is becoming increasingly important that we ensure these systems are making fair and equitable decisions. For decades we have been aware of biased and unfair decision making in many sectors of society. In recent years a growing body of evidence suggests these biases are being captured in data that are then used to build artificial intelligence and machine learning systems, which themselves perpetuate these biases. The question is then, can we detect these biases in the data before it is used to create these systems? In this paper we will be exploring the feasibility and effectiveness of using a technique from topological data analysis to detect unfair bias in a criminal sentencing dataset.

Laboulbeniales (Fungi) on Semi-Aquatic Veliidae (Insects) from Reserva Los Cedros in the Ecuadorian Andes

Stephanie Marie Travis
Advisor: Patricia Kaishian

My senior project investigates the relationship between Laboulbeniales (Ascomycota, Fungi) and semi-aquatic Heteroptera (Hemiptera, Insecta) collected in 2018 at the Los Cedros Biological Reserve located in the Ecuadorian Andes. Laboulbeniales are an order of fungi containing ectoparasitic fungi that grow on arthropod hosts, including Heteroptera, which is a relatively understudied yet diverse group of insects. For this work, I scanned insects for the presence of Laboulbeniales in order to explore infection rates, patterns of fungal growth on the insect body, and to look for potentially new fungal species. Using entomological pins, fungi were removed from the insects, and permanently mounted on slides. The infection rate was determined to be 3.549% and a heatmap of the insect body depicting concentrations of fungal growth was generated. The fungal species infecting the insects was identified as a member of the genus *Laboulbenia* and was determined to be a new, undescribed species. Also in this work, I discuss aspects of the social history of Reserva Los Cedros and the greater Ecuadorian Andes. I also explore the impacts of extractive industries like mining that threaten biodiversity and the livelihoods of indigenous peoples.

Diffeomorphisms of Time

Talia Willcott
Advisor: Harold Haggard

According to Newton, time is a consistent and reliable tool used to measure various physical quantities. According to Einstein, time is flexible and dependent on a number of external factors. There are many ways to analyze and bridge the gap between the two theories, one being mathematically. In this project, I examine three specific notions of time by representing time as a line, using projective geometry to relate the line to a circle, transforming the circle, and analyzing the physical implications of these transformations.

Localization and Mortality of Microplastics and Nanoplastics in *Danio Rerio* Embryos

Margaret Wolff
Advisor: Michael Tibbetts

Over the last century global plastic production has grown substantially. Plastics are a ubiquitous material in industry and daily life. With that production and usage, plastic pollution has also increased. The purpose of this experiment was to examine the effects of microplastics on *Danio rerio* embryos. The specific aim of this study was to determine whether the chorion has any effect on embryo mortality rates, or microplastic localization, in the presence of three sizes of microplastics. Microplastics of all sizes, in both chorionated and dechorionated embryos, accumulated at the perimeter of the yolk sac of the zebrafish embryos. Statistical analyses on the mortality data revealed that size of microplastic has no effect on the mortality rates of the zebrafish embryos; analyses did reveal that the presence of a chorion has a significant effect on zebrafish embryo mortality rates in each microplastic size group. Implications of these findings suggest that the chorion has an effect on the mortality rates of zebrafish embryos in the presence of microplastics—i.e. the chorion may offer the embryo protection from microplastics.

Win Big(k), Lose Big(k):
A Further Exploration of the Win Big and Lose Big Voting Systems

Rachael Yoder
Advisor: Lauren Rose

This project focuses on the mathematical study of ranked voting systems, where voters rank their candidates in order of preference. There are many different voting systems used to determine a winner from a given set of ballots, for example Plurality, Borda Count, Coombs, Instant Runoff, and Anti-plurality. Looking further into a previous senior project where the author created a new voting system that selects an average alternative, we analyze the long term results of those systems. Taking the Win Big(k), and Lose Big(k) methods we compare them to various pre-existing ranked voting methods.

Nigella Sativa oil as a Novel Anthelmintic Against Internal Nematode Parasites of Sheep

Regina Zavadzkas-Garza
Advisor: Brooke Jude

The Barber Pole Worm (*Haemonchus contortus*) has become a growing problem to the sheep industry around the world due its growing resistance to common anthelmintics and aggressive infection (Delano 2002). Anthelmintics are drugs that are used to combat parasitic infection, and those available are few and are therefore more prone to be over used which create a higher rate of resistance to occur in parasites (Besier 2003). Essential oils and plant extracts have shown evidence to have medicinal properties, such as antibacterial, anti-inflammatory, and antiparasitic that have been used for many years in traditional practices (Ferreira, 2018). These plant essential oils have also shown to have antiparasitic effects against relevant parasites found in sheep, pigs, and goats (Štrbac, 2022; Emine, 2021; Yimer, 2019). Black cumin seed oil (*Nigella sativa*) is an example of a plant extract that has medicinal and antiparasitic properties effective against parasites similar to the Barber Pole Worm (Emine, 2021). In order to test the antiparasitic capacity of black cumin seed oil, it was tested against internal parasite eggs sourced from infected sheep in the Hudson Valley in New York. The antiparasitic effects of the oil were tested in increasing concentrations against the eggs of the internal parasites from fecal samples of known infected sheep. A significant effect in preventing a certain percentage of eggs hatching was observed at different concentrations, especially to those exposed to treatments higher than 36% of black cumin seed oil. This study supports other research that indicates that black cumin seed oil has potential as a novel tool to combat growing parasitic resistance.