2026

science, mathematics & computing division

SENIOR PROJECT POSTER SESSION

Improving the Search for Sharac Quandles

Karomat Alimova
Advisor: Robert McGrail

The goal of this research is to discover more NP-complete quandles for the purpose of coloring knots within the Tait–Rolfsen Knot Table. This work reveals three ways in which the efficacy of a randomized algorithm was improved in order to discover more quandles. The first improvement was to develop a formula for the size of Sharac(n) quandles in order to tighten the search to acceptable size limits. The second was to reduce the search space for the Sharac(n) quandle where $n = n_1 \times n_2$; $\gcd(n_1, n_2) = 1$; $n_1, n_2 > 1$. In this case, one might restrict to a smaller search space of size $(n_1+n_2)! / (n_1 \times n_2)$ versus $(n - 1)!$. However, a divisibility condition on subquandles of connected quandles rules out this approach for most n within reasonable bounds. The last method limits the space of generators for the randomly selected quandle to those constructed by involutions. Eight new NP-complete quandles were discovered through the first and last methods.

Predictive Processing: An Adaptive Model

Ahmad Salman Alnoor
Advisor: Sven Anderson

Modern developments in cognitive science suggest that the brain is constantly making inferences about incoming sensory information in order to minimize surprise and uncertainty. These models suggest that the brain doesn't just passively receive information, it is at every moment actively predicting input. This is the core idea behind predictive coding. Prediction is also a central concept in adaptive resonance theory. In this paper, I will explore predictive coding in terms of ART1, to see whether Adaptive resonance can provide a computational ground to the theoretical framework of predictive coding.

Getting to the Root of the Problem: Exploring the Influence of Breeding History on the Assembly of the Soil Microbiome

Ani Alpert

Advisor: Gabriel Perron

Understanding the factors that dictate the composition of the soil microbial community is essential to continued agricultural innovation. Intensive farming practices have led to severe soil depletion, yet harnessing the soil microbiome may provide the only path forward to maintain current yields. Previous research suggests that plant genotype plays a key role in structuring microbial communities, as plants selectively recruit bacteria, fungi, and other microorganisms based on their physiological needs (Lund et al. 2022; Wagner 2021; Wagner 2022; Pérez-Jaramillo et al. 2016). However, modern agriculture has largely disrupted this mutualistic relationship, weakening the biological foundations of soil fertility. The goal of this project is to investigate how plant genotype shapes plant-microbe interactions in soil. More specifically, this study investigates how three squash genotypes, representing distinct domestication and breeding histories (a traditional landrace, an heirloom, and a modern cultivar) will differentially affect community structure and diversity in three microhabitats of the soil (bulk, rhizosphere and rhizoplane). I predict that landrace and heirloom varieties can be leveraged in future plant breeding programs to reestablish and sustain beneficial plant microbe interactions, thereby mitigating soil depletion. The results of this experiment indicate that breeding history didn't affect abundance significantly across varieties. The more notable result is that the taxonomy of the microbial community was significantly affected by breeding history.

The Effect of Teaching-Language Affectivity on Behavior and Motivation

Qizhi An
Advisor: Frank Scalzo

Confucian culture has deeply shaped East Asian society's collective belief in education as the key to social mobility. While this value system drives East Asian students to excel in international assessments, it often comes at the cost of mental health and overall development (S. Yan, 2023). The authoritative language commonly used in East Asian classrooms (e.g., "You must achieve perfection") is meant to motivate students but can also intensify self-doubt and low self-esteem, thereby stifling creativity and intrinsic motivation. By contrast, Western education tends to emphasize encouraging language (e.g., "Your idea is interesting") to promote student autonomy. Research in psychology suggests that the emotional tone of language (i.e, affectivity) influences behavior through its effect on emotions—positive language can spur exploratory behavior, whereas negative language may lead to avoidance (Fredrickson, 2001; Elliot, 2006). However, the specific independent effects of emotional tone (positive, neutral, or negative) on short-term learning motivation remain debated (Kluger & DeNisi, 1996).

This study focuses on immediate skill-based learning scenarios, such as musical instrument practice, and proposes an "emotion-dominant model" hypothesis: positive language significantly enhances short-term motivation and engagement, negative language diminishes motivation, and neutral language has little effect. To test this hypothesis, This study will conduct a pre-test/post-test control experiment with 45 participants randomly assigned to receive either positive, neutral, or negative instructions on the

affective component of learning a guqin instrument-fingering skill in a standardized teaching environment. The Situational Motivation Scale will be used in the pre-test and post-test, while researchers will also record the time spent focusing during the self-exploration section and rate each participant's final performance.

The experiment is expected to show that participants in the positive language group (e.g., “This performance has great potential!”) will demonstrate significantly higher motivation than those in the negative language group (e.g., “This does not meet the standard at all”), while the neutral language group will exhibit minimal motivation changes. Behavioral (performing) data are also anticipated to reveal that negative language prompts procrastination and avoidance behaviors. The examination of focus time data will demonstrate an increase in practice duration for the group receiving positive-tone instruction compared to those exposed to negative or neutral tones. These findings could offer educators empirical support for refining their communication strategies, suggesting that supportive language may more effectively maintain student engagement and foster long-term development through an “emotion-motivation” chain reaction.

Predictions of Evenness:
Effects of Species Diversity on Tree Productivity in a Temperate Mixed Hardwood Forest

Sydney Asher
Advisor: Cathy Collins

Relationships between tree species biodiversity and productivity are highly variable across scales, climates and biomes. There is a lack of knowledge on the influences of evenness (or the amount of individuals within species per area) on the mechanisms of ecosystem functioning that lead to tree community productivity. Research on diversity-productivity relationships has historically focused on the effects of species richness (or the number of species per area) in tropical forests. As such, researching the relationships between evenness and productivity in a temperate ecosystem is a novel approach. In this study, I studied how community evenness may impact the productivity of trees in a temperate forest. I conducted an observational study of ~700 trees in 20 plots across Bard College and Tivoli Bays near Annandale-On-Hudson, NY. I measured productivity in two ways, calculating above-ground biomass using species- specific allometric equations, as well as analyzing satellite imagery to attain NDVI (Normalized Difference Vegetation Index) and EVI (Enhanced Vegetation Index) values of tree canopy health. I did not find a correlation between NDVI or EVI productivity and diversity. There was an overall positive relationship between species richness and evenness in tree communities. Relationships between diversity and above-ground biomass differed between forest canopy level; I found relationships between richness, evenness and above-ground biomass in trees in the understory of canopies, but not the

overstory, suggesting that diversity-productivity dynamics differ even on fine scales within forests.

Post-Traumatic Growth in Displaced Afghan Adults: Coping, Stress, and Perceived Agency After Forced Migration

Missaq Bahar
Advisor: Justin Dainer-Best

Afghan refugees who fled after the 2021 Taliban takeover continue to navigate trauma, loss, and rebuilding identity. This study measures post-traumatic growth among displaced Afghan adults in the U.S., focusing on how coping strategies, post-migration stressors, and perceived agency interact. 83 participants completed surveys in English, Dari, or Pashto using PTGI-SF, Brief COPE, and agency scales. Results indicate moderate-to-high reported PTG (M = 44.3), with problem-focused and emotional coping predicting higher growth scores.

When Less Is More:
An Experimental Study of Menu Size and Decision Quality

Arghawan Bani
Advisors: Gautam Sethi & James Hobbs

We live in an era of unprecedented choice. From streaming platforms to supermarket shelves, consumers now face far more options and a greater cognitive burden than previous generations. This study challenged the neoclassical assumption that “more is better” by objectively measuring how menu size (small: 6, medium: 12, large: 24 options) impacts decision quality, rather than relying on self-reports. The quality was assessed by comparing each participant’s chosen option to the best option available on the same menu, using a controlled experimental design.

Beyond menu size, the study also explored two potential moderating factors: individual maximizing tendencies and whether the articulation of preferences could buffer against choice overload. Using a controlled experimental design, participants (n = 101) selected from menus of varying sizes, with decision quality measured by the proximity of their choices to each participant’s utility-maximizing option. Results demonstrated that larger menus significantly degraded decision quality (β = 0.09, t = 3.520, p < .001). As the menu size increased, participants systematically chose options farther from their optimal choice. While the effects of maximizing tendency and preference articulation were both consistent with the predicted direction, neither reached statistical significance. Overall, these results provide strong experimental evidence supporting the core claim that increased choice is not always better for consumer satisfaction.

Simultaneously Bisecting Two Sets of Lattice Points Using Zig-Zag Lines

Stephen Bassler
Advisor: Ethan Bloch

This project is a discrete version of the Ham Sandwich Theorem. My question is: Taking a set of red points and a set of blue points in an integer lattice, can we simultaneously bisect each of them (having equal numbers of red points on either side and blue points on either side) using a single zig-zag line? We are modeling this question by creating randomly-generated plots of red and blue points, and testing to see if it is always the case that there is at least one zig-zag line that bisects. If there are cases where there is no such line, we want to show that there is an upper bound to the discrepancy created by the zig-zag line (the difference between red points on either side of the zig-zag and the difference between blue points on either side of the zig-zag).

Setting Up for Success:
Bipolar Disorder, Dysfunction, and Group Therapy in the Undergraduate Age Group

Claire Bates
Advisors: Justin Dainer-Best & Seth Halvorson

When discussing treatment for bipolar disorder, there are many different options that exist today. While treatment with psychotropic medication will always be the first line of defence in treating symptoms caused by bipolar disorder, there are many discussions as to the therapeutic treatment that would be best in treating these symptoms when combined with said medication. Oftentimes these involve individual or group therapies, usually with a CBT or DBT skills based approach. This study proposal will focus on adapting a specific therapeutic strategy known as psychoeducation (specific education about an illness) for undergraduate students (aged 18-25) with bipolar disorder in Annandale-on-Hudson New York. 50 participants with bipolar disorder will be randomly assigned into either an experimental (n = 40) or control group (n = 10). I predict that an 8 week psychoeducation curriculum for bipolar disorder will be effective in increasing quality of life, decreasing occupational and social dysfunction, decreasing level of depression, and decreasing level of mania in the experimental group. I predict this outcome because I believe psychoeducation to be specifically effective for the age group I have selected for this experiment, and I believe that psychoeducation in general should be investigated more as a possible treatment for bipolar disorder.

When the Long Rains Run Dry: Identifying Areas of Heightened Risk, Exposure, and Vulnerability to Climate Change in Kenyan Communities

Charlotte Bermingham
Advisor: Felicia Keesing

Climate change is intensifying environmental stressors that disproportionately affect vulnerable populations, particularly in East Africa, where many livelihoods depend on climate-sensitive systems. This study identifies spatial patterns of biophysical exposure and vulnerability to climate change across Kenya by analyzing shifts in key bioclimatic variables. Using high-resolution raster data from the WorldClim v2.1 dataset (1970-2000 baseline) and CMIP6 future climate projections (ACCESS-CM2, SSP245, 2041-2060), this study focuses on three variables central to climate-related risk: Annual Mean Temperature (BIO1), Precipitation Seasonality (BIO15), and Precipitation of the Driest Quarter (BIO17). Spatial analyses were conducted in RStudio and visualized using an ArcGIS Pro workflow. Areas of elevated vulnerability were identified using quartile-based risk maps, with the highest-risk zones defined by the upper (or lower) quartiles of each climatic variable, indicating areas of intensified heat stress and precipitation variability. Results indicate a pronounced shift toward higher temperatures and increased rainfall variability across much of Kenya, with significant drought risk in the driest quarter. These changes suggest escalating risks to agriculture, water security, and human health, particularly in Kenya's arid and semi-arid regions. The findings show that while bioclimatic variables alone can effectively identify exposure hotspots, further integration of socioeconomic variables and community input is necessary for a comprehensive vulnerability assessment. The resulting maps

provide a foundation for targeting community-centered climate mitigation strategies, informing resource allocation, and supporting policy decisions to reduce human vulnerability in the face of accelerating climate change.

The Role of Socioeconomic Status in Contagious Yawning

Prisha Singh Bishen
Advisor: Christa Schmidt

Contagious yawning is thought to reflect mentalizing processes (Platek, 2010), and previous research suggests that individuals from lower socioeconomic status (SES) backgrounds exhibit heightened sensitivity to social cues (Keltner et al., 2010). This study investigated whether SES influences contagious yawning frequency, a reflexive social behavior. This project examined how photo and text stimuli of yawning may influence contagious yawning rates among participants from lower and higher SES groups. The results demonstrated that participants from higher SES backgrounds yawned less frequently than those from lower SES backgrounds. These findings suggest that socioeconomic status may be an important social factor to consider in contagion yawning. Future research directions about how to further study socioeconomic status, social attunement, cognitive processing, and empathy, and how they may be related to contagious yawning is discussed.

The Role of miR-29/miR-83 in the ER Unfolded Protein Response Modeled by *C. elegans*

Lexie Blackburn

Advisor: Rebecca Cox

Liver disease is a leading cause of death in the world, and is ranked eleventh in the United States. Although there is no current way to reverse advanced liver disease, if caught early and appropriately treated, the liver can then repair itself. Micro RNAs (miRs) are a class of non-coding RNAs that regulate gene expression, and have been found to be linked to many different kinds of cancer. Furthering our understanding of miRNA could provide new insights into the development and regulation of many diseases, such as cirrhosis. Recent work found a particular miRNA, miR-29, as an important biomarker in cells that experience protein-folding stress, which is seen when the endoplasmic reticulum (ER) starts detecting misfolded proteins. A recent study has linked the downregulation of miR-29 to improvements of lipid metabolism in fatty liver disease in dairy cows. MiR-29 has also been studied in many cellular systems, mainly in neurodegenerative diseases such as ALS or fibrotic diseases that plague the body. The ER-Unfolded Protein Response (UPR) plays an important role in lipid metabolism which brings to question how miR-29, the ER-UPR, and lipid metabolism may interact in the context of cirrhosis. Specifically in hepatocytes, we hypothesize that miR-29 interacts with at least one of the the three major pathways that the cell can activate during ER-related protein-folding stress: PERK, ATF6, or the IRE1α pathway. This leads me to my question of: which arm of the ER-UPR is regulated by miR-29? This experiment will be done with *Caenorhabditis elegans* (*C. elegans*) as a model organism to determine the ER-UPR-related targets of miR-29 (miR-83 in worms). To test this hypothesis, lifespan assays, and

ER-stress assays to determine how downregulation of miR-29/miR-83 affects target gene expressions, health and longevity.

Approximately 21,788,429,512 Dire Wolves Walk into a Bar: Estimating the Absolute Abundance of Extinct Dire Wolves

Mason Blank

Advisor: Felicia Keesing

Ecological information about extinct ecosystems such as population densities or generation times of extinct animals are just as important to our understanding of paleontology as morphological analysis of an animal's fossils. The structure of an organism's teeth is just as important as what organisms those teeth evolved to eat, and how prevalent those organisms were in their shared environment. By utilizing methods from Marshall et al., 2021 originally used solely for finding the preservation rate of Tyrannosaurus rex, estimates for this information can be made based on known data from information about extinct organisms and their modern relatives. The dire wolf (*Aenocyon dirus*) serves as a perfect test case for these methods; as there is a large sample size of known fossils in museum collections and it has close extant analogues to base assumptions off of in cases where it is impossible to gain the information from the fossils themselves. Future research utilizing these and other similar methods to garner information about other species in shared environments could help to create clearer pictures of the past and could even help to shed light on why certain species persisted into the modern day while others became extinct. Animals with fewer known fossil specimens or which are more distantly related to modern animals would be more difficult to test and would require more assumptions for the formulas to work, but in theory even more ancient environments totally unlike those of the Holocene could be better understood.

Investigating the Role of Ins-7 in Lifespan and Pathogen Susceptibility in a High-Glucose-Fed Microbiome of *C.elegans*

Katelyn Campoverde
Advisor: Robert Todd

Numerous studies have documented rising trends in sugar consumption worldwide. According to Yale Health, the average American consumes approximately 22 teaspoons of sugar per day, exceeding the American Heart Association's recommended intake of 6–9 teaspoons. In the roundworm *C. elegans*, high-glucose diets have been associated with increased gut permeability, greater susceptibility to pathogens, and reduced lifespan (Kingsley, 2024). Additionally, deletion of the insulin-like peptide gene *ins-7* in glucose-fed worms has been shown to increase longevity from 17 ± 0.7 days to 21.6 ± 0.5 days (Mendler, 2017). Despite these findings, the mechanisms linking *ins-7* deletion to changes in lifespan and pathogen susceptibility remain unclear.

This study investigates the role of *ins-7* in regulating longevity and pathogen susceptibility under high-glucose conditions. Using *C. elegans* as a model organism, worms lacking the *ins-7* gene were exposed to a glucose-rich diet of *Escherichia coli* OP50 to simulate a high-glucose fed microbiome. Our results showed that a high-glucose diet did not significantly decrease lifespan or increase pathogen susceptibility in either wild-type N2 worms or *ins-7*-deficient OH18835 worms. Suggesting that the interaction between glucose exposure and *ins-7* function is more complex than previously understood and may involve additional regulatory pathways influencing host health and disease susceptibility.

Childhood Trauma and its Relationship to Post Traumatic Stress

Alicia Carroll

Advisors: Elena Kim & Justin Dainer-Best

In the proposed research study I explore the relationship between childhood trauma and the likelihood to develop Post Traumatic Stress Symptoms (PTSS) when exposed to a traumatic event later in life. The research question- *Does an individual's childhood experience with safety, both physically and emotionally have an effect on their susceptibility to develop Post Traumatic Stress Symptoms?* In this study, participants have recently survived a mass shooting at their public high school. Within four weeks, they will take part in a self report research study by completing- A demographic questionnaire, Adverse Childhood Experiences Revised Questionnaire (California Surgeon General's Clinical Advisory Committee) , as well as the Child and Adolescent Trauma Screen (CATS) - 7-17 Years. The projected results of the study will be studied using Regression analysis as well as a Factorial Anova. I expect to see a statistically significant effect of gender, Adverse Childhood Experiences score and Post Traumatic Stress Symptoms.

Predicting the Influence of Music Education on Academic Performance in Children

Georgi Borislavov Chikolov
Advisor: Kerri-Ann Norton

Music education is frequently promoted as a way to improve children's cognitive development and academic performance. However, prior research on the topic has produced mixed findings, often due to differences in methods used and the underlying role of socioeconomic status. This project examines the relationship between music education and academic performance using data from the Panel Study of Income Dynamics Child Development Supplement (PSID-CDS) for 2014, 2019, and 2021. After data cleaning and normalization, 1,173 students remained in the sample. Statistical methods included descriptive analysis, t-tests, correlations, regression, and predictive modeling.

Results show that direct measures of music participation - taking lessons or general music involvement - were weak and inconsistent predictors of GPA. In contrast, having a musical instrument at home was the most stable and statistically significant predictor across all three years. The combined regression model explained 5.9% of the variance in GPA (R^2 = 0.059), suggesting that academic performance is influenced by factors beyond music variables. Predictive models also demonstrated limited explanatory power, reinforcing the complexity of academic performance.

The findings suggest that music education contributes to student success indirectly, through broader factors like household and environmental influences, rather than as a strong independent cause of higher academic performance. This project supports previous findings that music education is

a nuanced component of child development, rather than a standalone determinant of academic performance and outcomes.

The Effects of HFD and DSS-induced Gut Dysfunction on *Drosophila melanogaster* Female Reproductive Success

Marilyn Corbett
Advisor: Gabriel Perron

A high-fat diet (HFD) and Dextran Sodium Sulfate (DSS) both cause gut dysregulation through chronic inflammation and overactivation of the JAK/STAT and Imd/NFκB pathways. The relationship between gut dysregulation caused by these stressors and reproductive success is relatively understudied. Using *Drosophila melanogaster* as a model organism, we investigated the effects of HFD and DSS on female fecundity and fertility using a seven-day fertility assay that measured daily egg and larval output. Using these data, we calculated changes in both egg and larval output as measures of the consistency and magnitude of the treatment effect, and the hatch rate to assess the treatment effect on reproductive success. We hypothesized that, based on DSS's direct effect on gut dysfunction through epithelial cell damage compared to HFD's indirect effect through microbiome dysbiosis, DSS would have a stronger effect on fecundity, fertility, and reproductive success. We found that DSS had a stronger effect on both fecundity and fertility than HFD, consistent with our hypothesis. Neither HFD nor DSS had a significant overall effect on fecundity; however, both had time-dependent effects. DSS had an overall effect on fertility, whereas HFD had only a time-dependent effect. Interestingly, however, only HFD had a significant effect on reproductive success, suggesting that this treatment creates a gap between the number of eggs laid and the number of larvae produced. This is compared with DSS, which affected only fecundity and fertility. The findings suggest that HFD and DSS affect *Drosophila* reproductive success through distinct mechanisms due to their differences in gut dysregulation. These

investigations will have broader implications for how HFD affects offspring production and survival to term, as well as the expansion of DSS use in gut dysfunction research.

Flat Origami:
Star Graphs and Geometric Properties of Crease Patterns

Sophia Cornicello
Advisor: Lauren Rose

We focus on flat-foldable origami, a type of origami that can be closed in a book without adding any additional creases, and its relationship with graph theory and geometry. We define intuitive features of origami, including creases, faces, and folding angles, and clarify the difference between the crease pattern and the crease pattern graph. Using the case of star graphs as crease pattern graphs, we consider what geometric properties of a crease pattern, most notably in the form of angles between graph edges, lead to a flat-foldable origami.

Visiting the Unconscious:
The Role of Dream Recall in the Individuation Process

Isabella Correia
Advisor: Seth Halvorson

This proposed study will examine whether students who record their dreams report an improved sense of individuation over a trial period of 10 months (measured using a modified version of the Individuation Test for Emerging Adults), compared with students who do not record their dreams. For the purposes of the proposed study, individuation is defined as the process of developing and realizing one's distinct and unified sense of self. According to Jungian theory, the recollection and analysis of dream material can aid in this process by bringing unconscious material forth into conscious awareness. It is therefore hypothesized that participants in the dream recall condition, who will be asked to record their dreams in written form, will demonstrate statistically significant improvement on measures of individuation compared to those in the control conditions. Such findings would indicate a correlation between direct engagement with dream material and an improved sense of individuation over time, supporting Jung's theory that dream recall aids in the individuation process. The proposed study therefore contributes to the growing body of empirical psychological work on dream analysis by investigating the therapeutic potential of dream recall to facilitate the individuation process.

Again with the Guilt?
The Effect of Thinking about a Parent on Guilt among Jewish and non-Jewish Women

Lela H. Craig
Advisor: Natalie Wittlin

The strong desire to please and care for others, as well as the presence of guilt stemming from religion and the pressure to uphold specific values, may be what distinguishes the Jewish mother archetype from others (Helmreich, 1992). The purpose of this study is to examine Jewish daughters and their guilt level as it relates to thinking of their parents, specifically a mother and a father. This study found that Jewish participants and non-Jewish participants did not have differing guilt, so being Jewish did not lead participants to have higher guilt. These findings suggest that Jewish women do not have different guilt levels from other women. This shatters the stereotype of "Jewish guilt" as strongly prevalent in the thoughts and actions of Jewish people, specifically pertaining to their mothers. While this may negate the constructive perspective that guilt is an active, community based emotion, from the perspective that guilt is chronic and harmful these findings are hopeful. Additionally, reminding participants of one of their parents, mother or father, before asking them about their guilt did not lead them to higher guilt scores. This finding suggests that there is not a cycle of guilt shared from mother to daughter and so forth, since mothers did not feel increased guilt, nor did daughters.

Scrolling Digital Shelves:
Effects of Choice Overload on Food Decision-Making

Aislynn Dixon
Advisor: Sean O'Bryan

Consumers are confronted with an overwhelming amount of food products in online grocery shopping environments. Variety may contribute to preference alignment and perceived freedom, but may also inhibit or prevent choice. Research supports that extensive choice sets and their presentation may have cognitive demands that deplete self-regulatory resources, leading to less healthful food selections. The present study examined the effects of choice overload and categorization on food decision-making within a simulated online grocery shopping environment through a 2x2 mixed design. The manipulated variables are choice overload and categorization while the measured variables are healthfulness of food decision-making and overall satisfaction. Thirty people participated in the in-person study and completed two online shopping trials. The between-participant factor was between or within categorization, and the within-participant factor was extensive and limited choice sets. Food healthfulness was operationalized by the average Nutri-Score of shopping baskets and overall satisfaction was operationalized through an adapted satisfaction scale. A significant main effect of choice overload on Nutri-Score and a significant interaction between choice overload and categorization were found. The effect of assortment size on the healthfulness of food decision-making was most pronounced for between-categorization. These findings suggest the relationship between the effects of choice overload and the healthfulness of food decisions may operate within an assortment size threshold, and may be influenced by categorization. This study hopes to contribute to research concerning online

grocery shopping environments and has further implications for public health regarding the way that online store design may facilitate more healthful food choice.

Temperature and Moisture Alters the Severity of *Fusarium oxysporum* on Seed Germination

Shirley Dong
Advisor: Cathy Collins

Seed pathogens are often detrimental to the germination and survival of plants. Fusarium oxysporum is a common seed borne pathogen that primarily attacks agricultural crop species such as tomatoes and peppers and causes wilting in the affected plants. Thus from an economic standpoint, high abundance of *Fusarium oxysporum* can be detrimental to crop yields. Studies have shown that abiotic factors such as rises in temperature levels as well as high water availability increase the severity of fungal pathogens. Thus, with climate change bringing a rise in global temperatures and increases in soil moisture levels, understanding if these factors influence plant success can help us combat issues such as food security. Although studies have shown that temperature and moisture levels increase fungal pathogenicity on a single host species, less is known about the effect of abiotic factors on host-breadth, or the range of species the fungus infects. Even less is known about the interaction between temperature and moisture on the deadliness of seed pathogens.

Using a controlled lab experiment, I measured the germination success of six different plant species in the presence and absence of *Fusarium oxysporum* across three soil moisture levels and two temperature conditions. My results showed that the effects of fungus on seed germination depended on the environmental context. Specifically, I saw the strongest negative effects occurring under warmer temperature and high moisture conditions. These findings highlight the importance of continued research, as the effects of

fungi on seed germination remains difficult to predict, but suggests that climate change could significantly influence crop yields and plant diversity.

Two Birds, One Nest:
Impact of Interspecific Competition for the Use of Artificial Nest Sites on Cavity-nesting Birds

Savanah Doumbia
Advisor: Ellie Diamant

Interspecific competition for resources, such as food and shelter, is thought to have contributed to bird declines globally. In cavity-nesting birds, different species regularly compete for the use of artificial nest cavities installed by people. Although those artificial nest sites target native species, they are often used by invasive species such as House Sparrows (*Passer domesticus*) instead. There are numerous reports of (often aggressive) competitive interactions and nest usurpation events between different cavity-nesting species. Nevertheless, how nest occupants and their young are affected by these events of interspecific competition still needs to be investigated. I studied House Sparrows (*Passer domesticus*), Tree Swallows (*Tachycineta bicolor*), and Eastern Bluebirds (*Sialia sialis*) occupying nest boxes at Bard College, Annandale-on-Hudson, and monitored their breeding outcomes. I specifically explored whether the type and level of competition bird parents faced with other species affected how often they were able to feed their chicks, and how many of those chicks survived and fledged successfully. My results indicate that parental provisioning rate was not impacted by the occurrence of interspecific competition, whether indirect or aggressive. However, at nests facing aggressive competition, only 40% of chicks fledged successfully compared to 93 % at nests facing indirect competition, and 100% at those facing no competition. My study demonstrates that interference by competitors represents a considerable threat to the success of nestlings, and

provides evidence that the breeding activity of native birds at artificial nest sites remains limited by the occupation of boxes by invasive species.

Cog(nition) in the Machine: Do Workplace Stimulation and Social Engagement Predict Spatial Navigation?

Meredith Gardner

Advisor: Anne O'Dwyer

A person's understanding of their environment is modulated by the current sensory stimulation, and is further influenced by their social interactions. Spatial navigation, as a specific cognitive ability, has been demonstrated to be a useful tool in predicting cognitive decline. Social isolation has been shown to negatively influence cognitive functioning. Sensory stimulation and experiences have also demonstrated a relationship with cognitive functioning. The current study sought to test the hypothesis that social isolation and workplace sensory environment would predict spatial navigation ability. Twenty-eight adults completed an online survey that included the Steptoe Social Isolation Index, a measure of workplace indoor environmental quality (stimulation/satisfaction) survey, the De Jong Gierveld Loneliness Scale, and navigated within a virtual environment for spatial navigation through an online measure called Sea Hero Quest—across 5 levels of challenge. Results showed no significant correlation of workplace stimulation and spatial navigation scores. Social Isolation revealed limited support for the hypothesis—at one navigation skill level in Sea Hero Quest—Level 6. Loneliness correlated with social isolation and workplace stimulation/satisfaction, and Level 6 spatial navigation. Results are discussed in relation to the need for more robust measures of passive sensory input in order to further examine possible relationships with cognitive abilities, and further research into the identifying of specific facets of spatial navigation that indicate cognitive decline.

Framing Prosocial Work: How Incentives and Perceptions Shape Altruistic Behavior

Sam Gerber

Advisors: Tom Hutcheon & Dimitri Papdimitriou

This study investigates whether economic incentives and organizational framing influence prosocial motivation, and whether individual differences in altruistic motivation are associated with fairness behavior. Drawing on theories of crowding out and behavioral game theory, it was hypothesized that participants in an unpaid tutoring condition would report higher altruistic motivation than those in paid conditions, that a non-profit framing would produce higher altruistic motivation than a private company framing, and that individuals higher in altruistic motivation would demonstrate greater concern for fairness in an ultimatum game. One hundred and fifty participants were recruited via Prolific, of whom 148 were included in the final analysis. Results indicated no significant main effect of framing condition on the composite altruism index, though specific motivational items, particularly importance of pay and job versus service perception, showed sensitivity to condition. Contrary to expectations, altruistic motivation was negatively associated with minimum accepted offers in the ultimatum game, suggesting that highly altruistic individuals may be more willing to accept unequal splits.

Why did the Snake Cross the Road?
Snake Road Mortality and the Influence of Environmental Temperatures

Stephanie Giersz
Advisor: Felicia Keesing

Studying roadkill can give insight into species and ecosystem health. Snakes are an often overlooked group of animals, but can be used as bioindicators. Snakes are ectothermic, meaning they rely entirely on their surroundings to maintain proper body heat. Roads become ecological traps to snakes, as the heat retention ability of asphalt is very enticing for snakes to thermoregulate. There still remains a gap in research on how much the weather affects snake road mortality rates. This study asks whether daily air temperatures can predict the number of daily deceased snakes on the road. Surveys occurred each day from September 29, 2025, to November 8, 2025, along a 1.77 km stretch of asphalt road in Tivoli, NY.

The Effects of Propranolol as an Anxiolytic Drug on 5 Day Old Zebrafish Larvae

Joe Gluck

Advisor: Frank Scalzo

Existing research examining effects of propranolol's anxiolytic properties find that it produces a substantial effect of lowering elevated heart rate caused by anxiety both in humans and zebrafish larvae (Spadari et al., 2018; Fraysse et al., 2006). Other than this, existing research also finds that propranolol can produce an effect of decreased cardiovascular endurance when analyzed in humans (Spadari et al., 2018; Ades et al., 1988). The current study analyzed time spent in thigmotaxis of 5 days post fertilization(dpf) zebrafish larvae as a measure of anxiety-like behavior and analyzed if a 48 hour 1mg/l dosage of propranolol was able to reduce their time spent in thigmotaxis. Other than this, the study analyzed if this same dosage of propranolol was able to decrease distance moved of 5dpf zebrafish larvae during a 30 minute time frame with this distance moved being a measure of cardiovascular endurance. This study also analyzed the effects of a 4 hour 180mg/l dosage of caffeine in 5dpf larvae to establish if this dose increases distanced moved and time spent in thigmotaxis in larvae, as these increases are viewed as examples of elevated anxiety-like behavior (Maeda et al., 2021; Dumas, Ellis, & Wolfe, 2012). The current study could not reach any conclusions regarding movement behaviors of larvae as the movement data collected was afflicted with errors. These errors occurred due to tracking problems taking place in the Daniovision Chamber which was used to collect behavioral data on larvae in the current study. Analyses of caffeine on time spent in thigmotaxis were unable to establish a significant

effect of caffeine on thigmotaxis. However, the current study found that propranolol dosed larvae spent significantly less time in thigmotaxis when compared to control larvae which was interpreted as propranolol having the capability to treat behavioral symptoms of anxiety. This is a key finding as most existing literature regarding propranolols use for anxiety only recognizes its ability to reduce physical symptoms of anxiety and not behavioral or mental symptoms (Spadari et al., 2018; Fraysse et al., 2006). The implications of this finding suggests that propranolol has a much stronger case for usage as an anxiolytic drug than what's commonly seen.

Effects of Acute and Chronic Nicotine Exposure on Anxiety-Like Behavior in Zebrafish Larvae

Nitya Goyal

Advisor: Frank Scalzo

Nicotine is a widely used psychoactive compound whose effects on the central nervous system have been documented but its impact on early neurodevelopment and behavior remains less studied. The present study investigated the behavioral effects of acute and chronic nicotine exposure on larval zebrafish. Larvae were exposed to different nicotine concentrations (0, 5, 10, 20 mg/L) in both acute and chronic conditions. Locomotor behavior was assessed using Daniovision software. Behavioral measures included total distance travelled, velocity, time spent moving and time spent not moving. Results showed significant behavioral differences between exposure conditions. Chronic nicotine exposure was associated with increased total distance travelled and time spent moving and reduced velocity. Acute exposure had lower activity levels. Dose dependent effects were seen with higher nicotine concentrations having higher locomotor activity. Grand mean analyses showed increased activity and reduced rest in chronic exposure. The findings align with previous research showing nicotine's biphasic effects. However, there were several limitations including small sample size due to batch mortality and variability. Overall the study provides evidence that both exposure duration and concentration critically shape nicotine's behavioral effects during early development. These findings contribute to existing research on nicotine's behavioral impact and highlight the importance of zebrafish as a model for studying substance exposure and developmental toxicity.

Disability & Identity Safety Cues

Travis-Jude Green

Advisors: Justin Dainer-Best & Daniel Newsome

Identity safety cues are aspects of an environment that indicate to a person of a marginalized identity that they are valued in that space, and that there is less threat of discrimination. The proposed study examines the relationship of disabled people and identity safety cues, looking to understand whether they have recognizable symbols that can provide the benefits of safety, and whether disabled people benefit from safety cue transfer. It also seeks to discover whether provided accommodations can act as safety cues, and if frequent experiences with microaggressions lessen the effectiveness of cues in general. Participants were asked to sit in a waiting room alongside the cues and a number of confederates, and then completed a survey on their feelings of safety, past experience with microaggressions, and recognition of cues and symbols. The predicted results indicate that disabled people do benefit from both identity safety cues and from cue transfer, and that accommodations can act as cues in the right contexts. They also show that people who experience more microaggressions receive less benefits from identity safety cues than those who experience less.

Direct Laser Writing of Tungsten Oxide Microstructures for Colorimetric and Electrochemical Gas Sensing

Zander Grier

Advisor: Christopher LaFratta

This study reports the fabrication and characterization of platinum microwire-integrated tungsten oxide microstructures using femtosecond direct laser writing. Conductive platinum lines were successfully patterned from a precursor ink under multiphoton excitation, providing sturdy electrical contacts for sensing studies. WO_3 microstructures deposited onto these microwires exhibited reproducible responses to ammonia, demonstrating both quick chemiresistive changes and recoverable baseline resistance. Morphological analysis revealed a continuous, well-defined metallic pathway, demonstrating the efficacy of the laser-assisted deposition process. These results show the potential of direct laser writing for constructing miniaturized, high-performance gas sensors with integrated electrical functionality.

Climate Change and the Role of Deep-Water Formation in the Labrador Sea

Belén Gutiérrez

Advisor: Beate Liepert

Oceans play a major role in climate change particularly the northward transport and sinking of tropical waters. Overall, the study links atmospheric forcing to ocean interior ventilation through a sequence of buoyancy loss, instability, and geostrophic adjustment, demonstrating how deep convection emerges from the coupling of thermodynamic and rotational processes.This project examines the physical mechanisms governing vertical heat redistribution in the ocean, with a focus on deep-water formation in the Labrador Sea. The central question is how warm, buoyant surface waters typically stabilized by stratification are able to sink and ventilate the deep ocean. The results show that downwelling arises from the interaction between atmospheric cooling, buoyancy loss, and rotational ocean dynamics rather than simple gravitational sinking. In the Labrador Sea, exposure to cold, dry winter air drives strong surface heat loss from warm, saline waters transported northward by the Atlantic circulation. This cooling increases surface density until local stratification becomes unstable, triggering convective overturning, further enhanced by salinity increases associated with sea ice formation at the beginning of winter. In this study, we used observational and idealized data sets and an ocean wave-vortex model to simulate the processes described above. Firstly, I used as model input the TEOS-10 toolbox, which converts temperature and salinity fields into density and density anomalies. The dynamics are then interpreted using a wave–vortex decomposition framework, which separates balanced geostrophic motion from unbalanced wave and inertial components. This provides a structured view of how energy and motion are partitioned during

convection. Secondly I used idealized simulations to show that the initial buoyancy-driven collapse occurs on inertial timescales and is rapidly reorganized by Coriolis effects through geostrophic adjustment, forming coherent vortical structures. This highlights that early deep convection is strongly constrained by rotational dynamics, with balanced flow playing a dominant role in organizing the response.

Tracking Bacterial Persistence on Gym Surfaces: The Role of Surface Type and Oxivir Cleanser Effectiveness

Rachel Harris
Advisor: Brooke Jude

Gym surfaces are high-contact environments that have the potential to sustain diverse bacterial populations; surface materials and cleaning practices may influence which organisms remain recoverable over time. This study examined bacterial recovery from three cable grip surfaces in the Stevenson Athletic Center (copper, steel, and foam), with particular attention to the effectiveness of Oxivir, the hydrogen peroxide–based cleanser used in the facility. Bacterial isolates were collected by surface swabbing, cultured, and preserved as glycerol stocks. Selected isolates were further characterized and tested for susceptibility to Oxivir. Most recovered isolates were identified as *Staphylococcus* spp., with additional taxa also detected. In antimicrobial assays, Oxivir produced substantially smaller zones of inhibition when compared to the vancomycin control, and its inhibitory effect decreased with increasing dilution. Together, these findings suggest that high-contact gym surfaces can support persistent populations of primarily Gram-positive bacteria and that Oxivir showed limited inhibitory activity under the disc-based assay conditions used in this study.

Living with ‘Immigrant syndrome’: A Qualitative Study of Adaptation, Resilience, and Healing among Bosnian American Muslim Women

Verda Hasanovic
Advisor: Elena Kim

This is a qualitative study that explores Bosnian Muslim women who immigrated to the United States following the 1992-1995 war in Bosnia and Herzegovina. Semi-structured interviews were conducted with five women who immigrated to the United States shortly after the war. This study examines the process of adaptation, resilience and healing. Using thematic analysis the findings reveal that identity formation and adaptation is not a fixed outcome. It is a process that is shaped by displacement, caregiving roles, faith and everyday practices of coping. Participants describe adaptation as a necessity rooted in survival. Resilience comes up as something that is developed through enduring hardship rather than an individual trait. Healing is an ongoing process of carrying the past experiences while building meaningful lives in the present. Across all participants faith remains a constant. It serves as a stabilizing force which allows for participants to assert their identity. This study contributes to existing literature by centering the experiences of Bosnian Muslim women in the United States.

Finding Each Other: Queer Community & Resilience

Keary Hetherington

Advisor: Michael Sadowski

A strong body of research links community connection to wellbeing. There is also overwhelming research that shows that LGBTQ+ people are disproportionately at risk for negative mental, physical, and emotional outcomes. The established importance of community to wellbeing, as well as emerging studies looking at resilience as a factor of surviving discrimination and marginalization, point to a potential field of queer studies focusing on community. This research explores factors of community formation and factors that may influence an individual's ability to access and participate in community. Specifically, this study looks at experiences of LGBTQ+ people in queer spaces and asks how their sense of community is affected by identifying with more than one marginalized identity. The primary hypothesis explored whether there was a correlation between community connection and discrimination-associated risk levels and whether a participant was multiply marginalized. Results from data analyses indicated no statistically significant differences between "multiply marginalized" and "non-multiply marginalized" groups on community connectedness and discrimination-associated risk. Open-ended responses pointed to a need for further research investigating sexual modalities, accessibility and inclusion, and subgrouping (or "cliqueing") as factors in LGBTQ+ community.

Effects of Urbanization on European Starlings (*Sturnus vulgaris*) Phenotypes Over Time

Abby Hope
Advisor: Ellie Diamant

Urbanization has significantly altered the environmental characteristics of specific regions. Urban-associated birds have adapted morphologically to better suit the urban environment. European Starlings (*Sturnus vulgaris*) are a species of urban-associated bird common across North America and Europe. Urban-associated birds have been shown to have longer and stubbier beaks, shorter wings in proportion to their body, and smaller bodies compared to birds of the same species that live in rural environments. Prior studies have assumed that differences in phenotypes are due to selection for desirable traits in urban environments as opposed to rural environments. Those studies assume that urban and rural birds stem from the same population. By measuring specimens from the same area, I will be able to examine how increasing urbanization has altered the same European Starling population dating from 1889 to 2017. I measured beak shape, beak size in proportion to body, tarsus length, and relative wing loading to see whether variability can be explained by urbanization. Of the measured specimens, variation in morphological traits could not be explained by year. This could be due to differences in selected traits for the core and edge range populations, heterogeneity of urban landscapes, or the uneven timelines of urbanization between New York City and Long Island. My findings reveal the necessity of utilizing an urbanization gradient when testing for urbanization's effect on morphology. Urbanization gradients are more easily replicable across different cities and can reveal patterns that may otherwise go unnoticed with the broad-sweeping terms like "urban" versus "rural" or "suburban."

Framing Hope in Climate Change Education: How Stories Shape Young Children's Environmental Agency

Paige Houghton
Advisor: Sarah Dunphy-Lelii

This present study examined how story framing influences preschoolers' environmental agency. A total of 16 children (ages 3–5) participated and were randomly assigned to either a Hope condition or an Information-only condition. In the Hope condition, children were read stories in which a gender-neutral protagonist, Avery, actively helped solve environmental problems. In the Information-only condition, Avery noticed environmental problems but was unsure how to help. Following the stories, children completed a choice task, pre- and post-test agency measures, and a behavioral donation task. It was hypothesized that children in the Hope condition would be more likely to choose a helping ending, show greater increases in agency from pre- to post-test, and donate more acorns than children in the Information-only condition. Results indicated no significant effect of condition on story choice, with nearly all children selecting the helping ending. There was no significant interaction between time and condition for agency scores and no main effect of condition; however, a marginal main effect of time suggested a slight increase in agency across both conditions. Differences in donation behavior were also not statistically significant, although children in the Hope condition donated slightly more acorns on average. These findings suggest that children in this sample demonstrated high baseline levels of pro-environmental behavior, and that exposure to environmental content may support increases in perceived agency. This study highlights the importance of early childhood as a key

period for fostering environmental awareness and supports continued research on how to effectively engage young children in environmental issues.

Linear Quadratic Differential Games with Late Entry: Nash Equilibria and Subgame Decomposition

Emily (Shuai) Huang
Advisor: Stefan Mendez-Diez

This thesis develops a comprehensive framework for analyzing Linear Quadratic Differential Games (LQDGs) under varying information structures and participation constraints. We begin by establishing solution methodologies for standard two-player LQDGs: Pontryagin's Minimum Principle for open-loop games yields coupled Riccati differential equations, while the Nash Value Function approach for closed-loop games produces generalized Riccati partial differential equations. We then examine mixed-strategy LQDG where players face asymmetric information constraints, demonstrating how commitment limitations create strategic disadvantages. A key theoretical contribution is our extension of Bellman's Principle of Optimality to games with different intervals of play, establishing conditions under which subgame Nash control profiles aggregate to form a full-game Nash control profile. This framework is essential for analyzing games with delayed entry, where we develop a backward solution algorithm that constructs Nash control profile by recursively solving subgames. Applications to open-loop and closed-loop LQDGs with late entry demonstrate the practical applications of the subgame decomposition techniques. These results provide foundational tools for analyzing strategic interactions under realistic informational and temporal constraints, with applications ranging from market competition with delayed entry to policy coordination under measurement lags.

Detecting and Predicting DDoS Attacks with Machine Learning

Zakia Hussaini
Advisor: Valerie Barr

Distributed Denial of Service (DDoS) attacks are a major threat to network systems as they can overload services and make them unavailable to users. Detecting these attacks is challenging, especially in large and complex network traffic. In this project, supervised machine learning is used to detect DDoS attacks and to study the effect of feature selection on model performance. Five classifiers are evaluated, including decision tree, random forest, logistic regression, Support Vector Machine (SVM), and neural network. Feature selection methods are used to choose the most important features from the original 77 features, resulting in 24 features. The results show that tree-based models achieve very high performance on the original dataset. After feature selection, the models gave similar results, which shows that fewer features are enough to detect DDoS attacks. However, when tested on a completely different dataset (CICDDoS2019), the performance of all models dropped significantly. This highlights the challenge of generalization in machine learning, where models that perform well on known data may not perform as well on unseen data. Overall, the results show that feature selection helps reduce complexity and can improve performance, but it does not fully solve the problem of generalization.

Topologically Protected Quantum Memory for Quantum Computation

Diba Imran

Advisors: Sven Anderson & Stefan Mendez-Diez

In this project, we cover the mathematical foundations of quantum error correction and realizing quantum memories, from working through the core results and demonstrating the key properties of several codes, to analyzing one of the most promising and experimentally realized models of topological quantum error correction: the two-dimensional toric code. We look at the 2D toric code through the lens of the stabilizer formalism, which provides an algebraic language for error detection, and examine the partial reliance of this model on classical computation for decoding via the minimum-weight perfect matching algorithm. The 2D construction is analyzed in detail, a framework that generalizes naturally to higher dimensions, alongside recent advances pointing toward a realizable quantum memory.

Emotional Perception in the Dark: Race, Sound and the Horror Experience

Ryanna Isles-Lugo
Advisors: Joshua Nelson & Justin Dainer-Best

A majority of psychological research is focused on WEIRD populations (Henrich et al., 2010), which is not applicable to the vast majority of people, leaving a lot of the world's population as underrepresented. Subsequently, this sample of people becomes even larger given the lack of sociocultural and racialized identities. This proposal aims to explore how Black Americans perceive fear and anger as it pertains to horror movies. Thus, it will explore the effects of the race of the lead actor portraying the emotion (Black vs. White) and the presence of sound (Sound vs. Muted) on emotional perception. Based on research that delves into emotional psychology, sensory perception and sociocultural impacts, this study utilizes a 2 (Black vs. White) x 2 (Sound vs. Muted) x 2 (Fear vs. Anger) mixed design with 32 horror film clips. Due to practical constraints, data was simulated using generative AI. Simulated data suggests that Black actors are perceived as angrier, White actors are perceived as more fearful and the presence of sound overall will increase emotion elicitation across all conditions. Research conducted on emotions needs to incorporate racial, cultural and representational histories, namely as they are shown in various forms of media, like cinematography where racialized narratives and stigma surrounding emotions run rampant. Future directions and implications on more inclusive and conscious forms of representation in research are also covered.

How To Reframe and Reconstruct Our Past: Emotional Regulation through Memory Updating

Nia Jorbenadze

Advisor: Sean O'Bryan

The present study examined the effects of brief writing-based interventions, cognitive reappraisal (CR) and counterconditioning (CC), on the emotional and narrative processing of negative autobiographical memories over time. Although both approaches have been widely studied independently, few studies have directly compared them in naturalistic, non-clinical contexts. Eighteen participants completed two sessions spaced 5-10 days apart, during which they recalled and wrote about a personally meaningful negative memory under condition-specific instructions. Changes in emotional valence, emotional intensity, and narrative coherence were assessed across sessions. It was hypothesized that both CR and CC would reduce emotional distress (i.e., increase valence and decrease intensity) relative to the control condition, with CC maintaining greater narrative coherence. While primary analyses revealed no statistically significant effects of condition or time on key outcome measures, descriptive patterns and exploratory analyses indicated meaningful trends. Within the CC condition, more intensely positive memories were associated with smaller improvements in negative memory valence, suggesting possible contrast or stabilizing effects. Additionally, individuals who reported more frequent engagement with past experiences showed modest reductions in emotional intensity over time, though these effects were not statistically reliable. These findings underscore the importance of intervention duration, context, and individual differences in cognitive and emotional regulation. The results suggest that writing-based interventions such as CR and CC may be more effective when implemented over multiple sessions and tailored to individuals

already engaging with their memories and motivated to change their emotional and narrative effects.

Infection Spread on Networks with Finite Contagious Time:
A Probabilistic Approach

Amina Kanamatova
Advisor: Lauren Rose

This project studies the spread of infection on graphs using the probabilistic model in which each infected vertex remains contagious for exactly two time steps. We compute the probability distribution of the number of infected vertices and analyze the spread of infection on different graph families, including paths, cycles, stars, and complete graphs. We show that the infection process stabilizes after a finite number of steps and that graph structure plays a key role in determining the extent of spread. We also compare these results with the prior model in which contagion lasts for all future time steps.

Investigating the Effect of a Cold Thermal Event on the Reproduction of Blacklegged Ticks (*Ixodes scapularis*)

Juliet Kelly

Advisor: Felicia Keesing

Ticks are one of the primary vectors for zoonotic diseases in North America. The blacklegged tick, *Ixodes scapularis*, is capable of transmitting pathogens causing several of these diseases, including Lyme Disease, Anaplasmosis, and Babesiosis. Studies have shown that the *I. scapularis* habitat range is not only increasing, but that ticks are active for longer periods of time throughout the year. These factors could lead to an increased prevalence of ticks, thus posing a greater risk to human health. Several biotic and abiotic influences may be affecting this change in *I. scapularis* geographic and temporal range—one of which being temperature changes due to global climate change. While many studies and experiments have been carried out over the last several decades in an effort to understand the relationship between temperature and ticks, incongruities between findings, and gaps in several key areas leave the topic open for additional research effort. In particular, numerous studies have been done on the thermal tolerance of questing adults and immature ticks, but less is known about the potential impact of temperature on the reproductive fitness of engorged *I. scapularis*. Through lab experimentation on engorged (pregnant) *I. scapularis* individuals, collected from recently hunted white-tailed deer, I studied the effect of a 10-day cold thermal event on their reproductive fitness, specifically concerning their preoviposition and oviposition periods. While I did not find a significant effect of cold treatment, I did find a positive relationship between initial tick mass and oviposition duration, and trends in the data warrant further research.

Formal Verification of nftables

Kateryna Klimanova
Advisor: Robert McGrail

This senior project attempts to develop a verified formalization of nftables, the modern Linux kernel firewall, in the interactive theorem prover Lean 4. A big-step operational semantics for nftables packet evaluation is proposed, along with translation functions from legacy iptables to nftables. The semantic preservation argument between the two frameworks is approached using category theory as the underlying mathematical model, with a forward simulation theorem establishing that the translation preserves filtering behavior for every packet input covered by the formalized semantics. The simple firewall model of prior iptables work, a minimal model supporting a single flat list of rules suitable for static analysis, is extended with semantic constructs and set logic native to nftables.

The Conformal Particle, the Conformal Symmetry, and the Extended Path Integral

Thanasis Kostikas

Advisors: Stefan Mendez-Diez & Hal Haggard

Physical systems that possess a symmetry when studied using classical mechanics, but that symmetry is broken upon quantization exhibit a quantum mechanical anomaly. The breaking of the classical symmetry leads to unintuitive quantum phenomena such as the introduction of a length scale to the conformal particle. For this reason, the study of anomalous systems is important because it provides additional intuition for quantum phenomena. The conformal particle is an example of an anomalous system, describing a particle governed by a potential energy proportional to $1/x^2$ where x is the distance between the particle and the source of the potential. In this project, we study the conformal particle classically and quantum mechanically using Feynman's path integral approach. Although the path integral formulation of quantum mechanics produces deep insights about the behavior of particles, it needs to be extended to provide an accurate description for singular potentials. This extension gives rise to an intrinsic connection between physical systems and diffeomorphism invariance, which in turn highlights the importance of symmetries in the study of physics.

Constructing a EPR Spectrometer

Jiyu Kwon
Advisor: Paul Cadden-Zimansky

This senior project presents the design and construction of a low-frequency continuous-wave (CW) Electron Paramagnetic Resonance (EPR) spectrometer operating near 50 MHz. The work is motivated by an interest in directly probing the quantum-mechanical nature of electron spin and developing experimental techniques for the detection of weak RF signals.

Conventional X-band EPR systems (9–10 GHz) rely on precision microwave cavities, stringent mechanical tolerances, and highly stable RF sources, placing them beyond the practical scope of most undergraduate laboratories. By contrast, EPR operation in the RF regime requires only modest magnetic fields, enables resonator implementation using simple LC coils, and significantly relaxes mechanical and RF stability constraints.

The spectrometer integrates an RF signal generator, a custom inductively coupled resonant coil, reflection-mode detection with directional couplers, homodyne mixing, and magnetic-field modulation detected by a lock-in amplifier. Magnetic-field sweeps and data acquisition are fully automated using Python.

Initial measurements, including resonator characterization and RF-chain verification, culminated in the observation of a clear first-derivative EPR signal from a DPPH reference sample at approximately 50 MHz. This result verifies electron spin resonance in the RF regime and establishes the successful realization of a functional, low-frequency CW EPR spectrometer using accessible laboratory components.

Reviving the Past:
Identifying TikTok-Driven Revivals Through Data

Lexi Lanni
Advisor: Jordan Ayala

This project looks at whether TikTok has the ability to revive older music with scraped TikTok metadata and Billboard Hot 100 chart data. Fuzzy string matching was used to merge the two sets of data. Different fuzzy string matching algorithms were explored, but the two ultimately selected were Levenshtein distance and Jaro-Winkler due to being well-suited for short strings like song titles and artist names. Twenty songs were confirmed as revivals, meaning they charted before August 2018, the date TikTok merged with its predecessor, Musical.ly, and re-entered the charts after TikTok reached one billion monthly active users in September of 2021. The confirmed revival set had a wide range across decade and audio features, which was explored through exploratory data analysis and visualizations in R & RStudio, which suggests that TikTok does not discriminate by decade or sound, and that there is a relationship between short-form content and the lifespan of music that should be researched more in depth with a larger dataset. The results of the data were ultimately varied, with the confirmed revival set being dominated by Christmas songs and Taylor Swift re-recordings, which do fit the definition of a revival as established in the methods, but complicate the ability to directly attribute TikTok as the main reason for chart re-entry.

NyLaw: Dataset for Georgia's Civil Pro Se Court Cases

Nyla Lawrence
Advisor: Theresa Law

The legal process in the United States is extensive and prolonged. Artificial intelligence has already made its way through parts of the legal system, posing questions, and ethical and technical usage such as privacy concerns and reference hallucinations. In conjunction with the rise in artificial intelligence implemented into day-to-day living and work decisions, understanding the intersectionality between the two fields is critical. Instead of ignoring the inevitable higher integration of this technology, it is paramount that work is done to properly train and utilize these new systems for a more efficient and accurate legal process. To use machine learning requires the processing of thousands to millions of data points to accurately learn and predict or classify. Currently, there is not a concise dataset of civil state court cases, and especially none for pro se cases, that can train machine learning algorithms in the United States. This project curates one of these datasets of legal cases as a baseline, and quantifies them for immediate use within machine learning algorithms. As a pro se filer, this project could severely simplify the work done and the process to traverse their legal battle. It is constrained to one state to simplify the problem but can be simulated across states and jurisdictions for future works. Alongside being my home state, Georgia is currently evaluating this same intersectionality within judicial committees, making it the choice of state to be in line with current research on the topic.

Bridging the Gap:
How Sex Education Shapes Women's Sexual Pleasure

Violet Jean Leitch
Advisor: Sarah Dunphy-Lelii

Despite well-documented gender disparities in orgasm frequency and sexual satisfaction, the educational and embodied pathways through which these gaps are produced remain understudied. This study examined whether the content and emotional climate of formal sex education are associated with adult sexual functioning in women, and whether this relationship operates through internalized sexual shame and interoceptive awareness. One hundred cisgender heterosexual women (ages 22–45) completed an online survey including the Sex Education and Sexual Shame Questionnaire (SESS), a newly developed measure assessing sex education content, emotional tone, and internalized sexual shame; the Multidimensional Assessment of Interoceptive Awareness (MAIA-2); and the Female Sexual Function Index (FSFI). Consistent with hypotheses, more restrictive and shame-based sex education was associated with poorer overall sexual functioning. A serial mediation model showed that this relationship operates indirectly, in that more restrictive sex education predicted greater internalized sexual shame, which in turn predicted lower interoceptive awareness and ultimately poorer sexual functioning, with sexual satisfaction emerging as a central outcome. These findings suggest that sex education may shape adult sexual well-being not only through the information it conveys, but through its lasting impact on emotional experience and embodied pleasure. Exploratory analyses offer additional insights with implications for sex education practice and future research.

Detecting Dynamic Tempo within a Musical Piece by Revising the Beatroot Algorithm

Junyu Lin
Advisor: Kerri-Ann Norton

This senior project develops an offline music analysis tool capable of detecting tempo (BPM: beats per minutes) changes within a musical piece. The implementation begins with a reconstruction of Dixon's BeatRoot algorithm, followed by a recursive refinement. The improvement process went through two stages. The algorithm developed in the first stage detects a single BPM change, whereas the enhanced version in the second stage reliably identifies more than two BPM changes. As a result of this project, the algorithm detects Dynamic Tempo music with relatively simple instrumental arrangements. It outputs n change points and the corresponding n + 1 BPM values—each BPM value representing the tempo of the segment bounded by adjacent change points.

Women's Voices in Feminist Movements: A Listening Guide Analysis

Brenda Lopez

Advisor: Michael Sadowski

Despite growing research on feminist movements, relatively little research examines the lived, psychological experience of becoming and being a feminist in the twenty-first century. This study investigates what the personal narratives of women who participate in feminist movements reveal about how that participation shapes their sense of identity. Using Listening Guide methodology (Brown & Gilligan, 1992) with three participants, the analysis surfaced multiple simultaneous voices, including an activist voice, a voice of reasoning, and a critic voice, showing the internal negotiation women undertake in order to speak, as well as the constant struggle between what they feel, what they believe is acceptable to feel, and what they are willing to say out loud. Findings also suggest that collective feminist identity is not inherited but is actively and continually constructed, and that the rejection of hierarchy within feminist spaces constitutes a meaningful political act that challenges the structural reproduction of patriarchal power.

Exploring Habituation to Acoustic Stimulation in Zebrafish Larvae (*Danio rerio*)

David MacKay

Advisor: Frank Scalzo

Habituation research using the zebrafish (*Danio rerio*) animal model finds that zebrafish larvae reduce their behavioral response to acoustic stimuli when it is presented rapidly and repeatedly (Best et al., 2008; Kirshenbaum et al., 2019; López-Schier, 2019). Though this finding is consistent in the literature, studies typically use acoustic stimulation that does not differ from repeated bursts of rapid tones, and reductions in behavioral response are primarily qualified by bends in the bodies of the larvae (Best et al., 2008; Kirshenbaum et al., 2019; López-Schier, 2019; Roberts et al., 2011). The present study analyzed the tendency of larval zebrafish 6 days post fertilization to reduce their behavioral response to acoustic stimulation of 400 hertz, 900 second tones played on an air speaker. 144 zebrafish larvae (72 per condition) were assigned to one of two conditions: No sound, and Sound. In the sound condition, larval zebrafish at 6 days post fertilization were exposed to acoustic stimulation over the course of 3 blocks, and once under observation, such that they experienced the 400 hertz, 900 second tone 4 times in total. In the no sound condition, larval zebrafish 6 days post fertilization were exposed to acoustic stimulation of a 400 hertz, 900 second tone only under observation. Behavioral analysis did not yield any significant difference between sound conditions, such that larval zebrafish did not display significantly different distances moved, times spent in motion, or times spent not in motion. However, analysis of behavior across central and peripheral areas of their environment showed significant differences in behavior (total distance moved, time spent in and not in motion), such that

larval zebrafish in the sound condition demonstrated reductions in behavioral response to acoustic stimulation.

What Goes Around Comes Around: Determining the Number of Components for Front Multi-Crossing Number Two Links Using Permutations

Maya Magnuski
Advisor: Caitlin Leverson

A knot is a closed curve in $\mathbb{R}^3$ that does not intersect itself. Legendrian knots are knots satisfying additional geometric conditions. Front projections of Legendrian knots have the property that the more negatively sloped strand will always be on top of a more positively sloped strand. This property becomes particularly useful when looking at multi-crossing projections, where we allow for more than two strands to intersect at any point. In his 2025 Bachelor's thesis, Josh Krienke defines the front multi-crossing number invariant for smooth links. This is the minimum number of multi-crossings over all the front projections of Legendrian knots smoothly isotopic to a link. Using Krienke's classification of smooth links with front multi-crossing number two, we develop a method for tracking the movement of strands around a link using algebraic permutations. With this method, we are able to determine the number of components for numerous families of links of this form.

Stress, Antioxidants, and Memory in Older Adults

Aida Malikova

Advisor: Thomas Hutcheon

Cognitive decline is one of the most detrimental consequences of aging, with many older adults experiencing problems with memory, attention, and executive functioning. It can significantly affect independence and reduce the quality of life. Although age-related memory decline is well-documented, the biological mechanisms underlying this process are not fully understood, which limits the ability to develop effective interventions. Oxidative stress, defined as an imbalance between reactive oxygen species and the antioxidant defense system, is proposed to be a central contributor to neural deterioration. At the same time, antioxidant supplementation may be a promising strategy for mitigating oxidative damage and preserving cognitive function. However, findings in this area are inconsistent, and further research is needed to identify other factors that may interfere with the effectiveness of antioxidant supplementation. The current study proposes to examine chronic stress, specifically through cortisol levels in the organism, as a potential factor that exacerbates oxidative damage and accelerates cognitive decline in older adults. The primary objective of this paper is to investigate the interplay between chronic stress, oxidative stress, and memory performance, and to propose a study design that clarifies the mechanisms of cognitive aging and contributes to the development of more targeted and effective interventions for preserving memory in older adults.

Descriptive Quandle Theory: Size Patterns in Sharac(n) Quandles

Husna Manalai

Advisor: Robert McGrail

This project studies the size patterns of the Sharac(n) quandles. These quandles arise from conjugation in symmetric groups and are motivated by knot coloring problems that can be viewed as constraint satisfaction problems. The main goal is to understand how the size of Sharac(n) depends on n, and in particular why the formulas differ when n is prime versus composite.

Investigation of Swimming Pattern Formation in *Janthinobacterium* Strain via Transposon Mutagenesis and Agent-Based Modeling

George Matitashvili
Advisors: Brooke Jude & Kerri-Ann Norton

Janthinobacterium sp. BJB466 produces a reproducible bullseye-like speckled pattern during swimming motility assay, a phenotype unusual for swimming, which is generally considered as individual-cell dispersal behaviour. This study investigated the genetic and mechanistic basis of this phenotype through two complementary approaches: pRL27-mediated transposon mutagenesis with whole genome sequencing, and agent-based computational modeling. A library of approximately 3,500 transposon mutants was constructed and 361 strains with altered phenotypes were identified. Ten representative mutants were sequenced and transposon insertion site analysis identified disruptions in genes involving flagellar assembly, outer membrane integrity, central metabolism, nutrient sensing. The three agent-based models developed and tested experimentally incorporated run-and-tumble motility, chemotaxis, and quorum sensing. The chemotaxis model produced the strongest emergent spatial clustering resembling the speckled BJB466 phenotype. Together the computational and genetic findings converge on chemotaxis-driven nutrient sensing as a key contributor to pattern formation in BJB466, while the diverse array of disrupted genes suggests that the full mechanism involves interaction of multiple cellular processes.

S6 Segment Architecture and Cannabidiol (CBD) Binding in KCNQ2-Associated Developmental Epileptic Encephalopathy

Rio Maule
Advisor: Kate Huffer

KCNQ2 developmental epileptic encephalopathy (KCNQ2-DEE) is a severe form of epilepsy that begins in infancy and is caused by mutations in a potassium channel, regulating electrical activity in the brain, called KCNQ2. When KCNQ2 malfunctions, neurons become overly excited and active, causing seizures to occur. These seizures are severe, and lead to many developmental delays later in life. Understanding how these mutations can impact channel function is vital for creating targeted treatments for the future. Past research has shown that KCNQ2 mutations decrease the channels activity and that cannabidiol (CBD) can regulate potassium channels function in some cases. Although this is true, the impact of CBD on most distinct mutations that cause seizures continues to be unresolved. This study's aim was to determine how these differing KCNQ2 mutations might be impacted by CBD binding to the potassium channel. To attempt to explore this, computational molecular docking software was used to view the interactions between CBD and wild-type as well as the mutant channels. The findings revealed that many mutations maintained CBD's binding to the channel at very similar levels to the unmutated, wild-type channel, while the other mutations tested showed a reduced binding affinity. The mutations that impacted amino acids that faced directly into the pocket where binding occurs showed a greater influence on CBDs interactions than the mutations located away from the site. These outcomes demonstrated that the position, structurally, of a certain mutation plays an important role in knowing its

effect on CBD binding. This study explores how the differences in a protein structure might influence the future treatment response, more specifically in genetic epilepsy.

Untangling Data:
A Database Design for Knot Classification

Sahiba Mehry
Advisor: Robert McGrail

This project designs and implements a SQL database to store and organize knot and braid data, including presentations, crossings, colorings, and quandles. The goal is to make coloring-related information easier to access, query, and visualize for students and researchers. The database structure is based on an entity–relationship diagram that captures connections between knots, braids, quandles, and colorings, allowing users to study computational properties of knot colorings in a systematic way.

In simple terms, the database turns complex mathematical objects into structured data that can be explored like any other dataset. It helps users quickly compare knots, test colorings, and analyze patterns that would be difficult to see by hand.

Characterizing the Molecular Composition of the Cloud Tops of Venus:
The Culmination of a Three-Year Long Conversation

Lauren Mendoza
Advisors: Clara Sousa-Silva & Harold Haggard

In 2020, claims of the detection of phosphine (PH_3)in the atmosphere of Venus sparked renewed interest in its atmosphere and ignited debate because of PH_3's status as a potential biosignature. These claims also motivated a proposal to produce an infrared spectrum of the cloud tops of Venus on two nights of observation. The proposed wavenumber ranges have not been studied previously and are distinct for their lack of carbon dioxide (CO_2) transitions, a molecule that makes up 96% of Venus's atmosphere. This increases the likelihood of detecting less abundant molecules in Venus's atmosphere, such as sulfur dioxide (SO_2) and PH_3, which are relatively spectrally strong in these infrared wavenumber regions. However, preliminary analysis of the 2021 data revealed a flat spectrum despite this molecular activity. At the time of observation in 2021, 90% of the Venus disk was illuminated by the Sun. Conversely, in August-September 2025, the illuminated fraction of Venus was around 75%, which is very similar to the illumination during the JCMT and ALMA observations (around 78%). Therefore, observations were repeated in 2025 to observe slightly more of the Venusian disk in darkness, increasing the predicted abundance of molecules subject to photolysis (like PH_3 and SO_2), and increasing the chance of detecting these molecules in the spectra. Here, I detail the results of the analysis of the 2025 observations in comparison with further analysis of the 2021 observations. I confirm that both sets of data are characterized by flat

spectra and, via the results of this comparison, discuss whether or not the candidate molecules studied are present in Venus's atmosphere.

Precrastination in Physical and Mental Tasks: Comparing Patterns in First Responders vs Non First Responders

Nicole Meselsohn

Advisor: Thomas Hutcheon

Precrastination has been defined as the tendency to start a task as soon as possible, even at the cost of additional effort. This phenomenon has been observed in physical tasks, during which participants are asked to select one of two buckets to carry to a target, and in cognitive tasks, where participants are tasked with reading a number string at one of two bucket locations and mentally carrying the number string to a target. Although the exact characteristics that modulate an individual's rate of precrastination are still unclear, prior research has highlighted correlations between the tendency to precrastinate and certain personality traits part of the Big Five. Separate studies have also portrayed first responders (i.e. Emergency Medical Technicians, Firefighters, Police/Corrections Officers, etc.) as having significantly different levels of these personality traits compared to non first responders. This study aimed to determine whether there is a relationship between first responders and the tendency to precrastinate. Both the first responder and non first responder groups had 13 participants. Results revealed no significant difference between first responders and non first responders with regards to an overall tendency to precrastinate. Results also showed a marginally significant relationship between neuroticism and the tendency to precrastinate between both groups; however, first responders alone presented with a significant correlation between agreeableness and overall rate of precrastination while non first responders alone did not

exhibit any correlations between the Big Five personality traits and the overall tendency to precrastinate.

Visible-light Catalyzed, Intermolecular [2 + 2] Photocycloadditions for Preparation of Highly Substituted Cyclobutanes

Maryam Mohibby
Advisor: Emily McLaughlin

Compounds containing four-membered rings are valuable motifs in synthetic chemistry due to their unique structural and chemical properties. Visible-light photocatalysis offers a mild and efficient approach to access these strained systems. In this work, a substituted pyranone heterocycle was synthesized and reacted under visible-light mediated intermolecular [2 + 2] photocycloaddition conditions using an iridium polypyridyl photocatalyst. The reactivity of this system was explored using electron deficient alkene coupling partners, including methyl acrylate and *N,N*-dimethylacrylamide, to evaluate their influence on cyclobutane formation. These studies demonstrate the successful formation of cyclobutane products with good yield and high regioselectivity and provide insight into how substrate variation impacts reaction outcomes. Products were analyzed using 1D and 2D NMR analysis. This work highlights the potential of pyranone in visible-light photocycloaddition chemistry and contributes to the broader understanding of factors affecting selectivity in these transformations.

Environmental Stress Tolerance in Probiotic Lactobacillus Strains:
Implications for Gastrointestinal Viability and Bettering Athlete Health

Kane Morgan
Advisor: Brooke Jude

Lactobacillus rhamnosus and *Lactobacillus plantarum* are lactic acid bacteria that are commonly found in fermented dairy products and recognized for their probiotic properties. This study examined how these two bacterial strains respond to environmental stressors related to gastrointestinal-like conditions, specifically pH and temperature. Cultures were grown in MRS broth and exposed to three pH conditions (pH 4.94, pH 6.89, and pH 9) and three temperature conditions (20 °C, 37 °C, and 42 °C). Bacterial viability was measured by plating diluted cultures on MRS agar and calculating colony-forming units per millimeter. Across heat trials, *L. planatrum* and *L. rhamnosus* showed similar viability patterns with reduced survival at 42 °C compared with lower temperatures. The pH trials produced more variable results, with the clearest strain-level difference occurring at pH 6.89 in trial 2, where *L. rhamnosus* showed higher viability than *L. plantarum*. These findings suggest that environmental stress affects the survival of both strains, but that strain-specific differences may depend on the type and severity of the stress condition. Because athletes regularly experience physical and physiological stressors that can affect gastrointestinal function, understanding how lactic acid bacteria maintain viability

under pH and temperature stress can help evaluate their potential as probiotics to support gut health in athletic populations.

Full Characterization and Testing of Nontuberculosis Mycobacterium (NTM) Strain: Mycobacterium abscessus, Cultured from Pediatric Patients Lymph Nodes

Habiba Musah
Advisor: Brooke Jude

Nontuberculosis mycobacterium (NTM) are a complex species of mycobacteria related to *Mycobacterium tuberculosis*, a bacterium that infects humans, typically causing pulmonary diseases but can also cause infections in other parts of the body, such as the lungs, kidneys, and brain. NTMs are opportunistic pathogens, causing infections in individuals with compromised immune protection. They are commonly found in soil and water, and in patients can cause lung disease, lymph node infections, and other soft tissue diseases. It is common for there to be multiple related NTM species in a clinical sample, as well as near genetically identical colonies with differing physical characteristics. Therefore continuing to identify the genomes of new samples can have beneficial implications in adding to NTM library data. This is also beneficial in clinical situations, with more genome information, faster identification time and therefore faster treatment response time is possible. In this study a full characterization of a patient sample isolated from a pediatric lymph node was performed resulting in the sample being identified as *Mycobacteroides abscessus* (*M.abscessus*). Phenotypic morphologies of the mycobacterium strains from the sample were isolated resulting in two samples A and B, which were then stained and imaged. Using a high purity DNA extraction protocol, DNA samples were extracted and isolates were sent for Illumina whole genomes sequencing with analysis done using GalaxyEU and BV-BRC. This research could help

with finding out optimal treatments for infections in the future and lead to further projects looking at other strains of NTMs.

Dissemination of Antibiotic Resistance Genes in a Freshwater System with a Wastewater Treatment Plant

Koei Nakamura

Advisors: M. Elias Dueker & Gabriel Perron

Resistance genes conferring antimicrobial resistance represent one of the greatest threats to modern global public health. Environmental factors have recently been investigated for their role in the dissemination and proliferation of antimicrobial resistance genes, yet their contributions are not fully understood. This is especially pronounced in freshwater water bodies, where environmental and anthropogenic pressures converge. Studies are typically limited to short-term sampling of resistance genes and explanatory factors, failing to capture the long-term, multi-factor nature of resistance gene dynamics in water bodies. To overcome these limitations, this study utilizes comprehensive community-driven water quality data spanning 10 years in the Saw Kill, a 23.0 km Hudson River tributary, containing environmental and anthropogenic factors. To assess relationships between sewage contamination and antibiotic resistance in freshwater, the anthropogenic pollution and antimicrobial resistance gene marker, *intI1*, is quantified and modeled against coliform abundance. This study finds that wastewater treatment plants significantly increase the relative abundance of *intI1* but does not elevate coliform abundance downstream. Furthermore, *intI1* relative abundance peaks in summer and fall, but with a comparatively smaller seasonal effect than coliforms. These results can help inform water quality policy and safety measures around wastewater treatment plants across different seasons.

Mitigating Bias in Race and Gender Classification Systems

Joseph Nartey
Advisor: Valerie Barr

Mitigating Bias in Race and Gender Classifications is a senior project aimed to reduce the biased performance that we see in image classification systems that are geared towards classifying someone's race and gender. The performance stems from an insufficient training set, largely underrepresenting people, mainly people of color. The main question that is being asked is "What does it mean for a dataset to be ideal?" In order to solve that question, three training datasets were created to represent three possible different approaches. A Convolutional Neural Network was trained on each one, which gives three models, with each one being evaluated on its accuracy towards many race and gender groups, organized based on the US Census. Data has been sourced from publicly available datasets, as well as surveying the Bard student body.

HyperFocus:
Design and Evaluation of an Assistive Tool for College Students with ADHD and Reading Difficulties

Thao Nguyen Nguyen
Advisor: Theresa Law

Students with Attention-Deficit/Hyperactivity Disorder (ADHD) and/or reading disabilities such as dyslexia often experience significant challenges when engaging with complex texts. This project aims to design and evaluate an Assistive Technology prototype, called HyperFocus, which implements Optical Character Recognition (OCR) to transform static PDF text or image-based text into a dynamic, interactive format, integrating features designed to actively reduce cognitive barriers, improve reading fluency, and maintain engagement and focus. This tool was assessed through a within-subject user study with a group of 14 college students, comparing their reading experience using a traditional PDF viewer to using HyperFocus. The study revealed that while there are no statistically significant differences in reading time, quiz taking time or comprehension performance, participants reported increased engagement, reduced cognitive load, improved focus, and greater confidence in understanding the text when using HyperFocus compared to the traditional PDF viewer. Findings from the study also offer comprehensive feedback and suggestions for improving the design of HyperFocus, as well as future assistive reading applications. HyperFocus is available to try out on a web-based platform.

Cell-Type Dynamical Systems: Derivation, Implementation, and Validation in JAX

Njeri Njoroge

Advisors: Sven Anderson & Stefan Mendez-Diez

A central goal of computational neuroscience is to understand how neural populations encode, transform, and decode information through structured population activity. Cell-Type Dynamical Systems (CTDS), introduced by Jha et al. (2024), extend the standard linear dynamical system by constraining the dynamics matrix to obey Dale's law and the emission matrix to be block-diagonal and non-negative, producing a model whose parameters are directly interpretable as cell-type-resolved circuit connectivity.

This senior project presents a complete, mathematically derived, and empirically validated implementation of CTDS in JAX. We derive the full expectation-maximization algorithm for CTDS from first principles: the Q-function decomposition into three independent parameter blocks, the exact E-step via Kalman filtering and RTS smoothing, and the constrained M-step updates, which reduce to a box-constrained quadratic program for the dynamics matrix A and a vmapped per-neuron non-negative quadratic program for the emission matrix C. We describe the software architecture in detail, including the NamedTuple-based parameter representation, the Dynamax inference backend, JIT compilation via XLA, and the gauge-fixing convention applied after every M-step. We validate the implementation through two layers of tests: a suite of code-correctness checks verifying that each subroutine matches its mathematical specification, and a controlled benchmark against the original ssm-based implementation.

Machine Learning Based Intrusion Detection System

Rodaba Noori

Advisor: Sven Anderson

Cyber attacks such as denial-of-service, brute force, and web-based attacks continue to threaten modern networks, causing service disruption and data breaches. Intrusion detection systems are widely used to identify these attacks, but their effectiveness depends on how well they generalize across different network environments.

This study evaluates machine learning models for intrusion detection using multiple datasets, including CIC-IDS2017, LUFlow20, and UNSW-NB15, with a focus on cross-dataset generalization. The results show that while models achieve high performance when trained and tested on the same dataset, their performance drops significantly on unseen data. In particular, models fail to generalize well to UNSW-NB15, highlighting limitations in detecting attacks across new network environments.

These findings suggest that current IDS models rely on dataset-specific patterns rather than general characteristics of cyber attacks, emphasizing the need for more robust and generalizable approaches.

Measuring ADHD Masking Across Gender and Evaluating its Effects Through the Lens of Emotional Control

Alex Norrenberns

Advisor: Elena Kim

This study analyzes the phenomenon of masking in individuals with ADHD. A review of the relevant literature explores where the term comes from, its implications, and how it is measured. The research centers around its relation to gender and emotional control. An instrument designed to measure ADHD masking was constructed for the purposes of this study. Testing whether women mask more than men may provide a possible explanation as to why women are found to be underdiagnosed with ADHD. Additionally, the research compares masking scores to scores to an instrument that measures emotional control. Finding a relationship between the two may offer insight into understanding ADHD masking better and its potential clinical indicators.

Processing Costs or Crosslinguistic Influence? Testing the Interface Hypothesis in English-Italian and Spanish-Italian Bilinguals

Melina N. Collado

Advisor: Grace deMeurisse

This study investigates second language (L2) sentence processing at the syntax-discourse interface, focusing on whether processing difficulties arise from cross-linguistic influence or general cognitive constraints associated with bilingualism. Native Italian speakers, L1 (first language) Spanish-L2 Italian learners, and L1 English-L2 Italian learners completed a self-paced reading task manipulating grammaticality and topic shift. It was predicted that L1 English learners would show greater processing difficulty than L1 Spanish learners due to typological differences between their first language and Italian. The results revealed no significant main effects or interactions involving Language Group, indicating similar processing patterns across all groups. A marginal effect of grammaticality emerged in spillover regions, suggesting delayed processing costs consistent with incremental integration mechanisms. Unexpectedly, non-topic shift sentences elicited longer reading times than both topic shift and ungrammatical conditions. No effects of topic shift were observed. These findings challenge accounts that attribute L2 processing difficulty primarily to L1 transfer and instead support a processing-based explanation in which all speakers experience similar integration demands during real-time comprehension. However, overall performance near chance and substantial individual variability suggest that task sensitivity and small sample size may have limited the detection of subtle effects. The results support models of sentence processing that

emphasize shared cognitive mechanisms across native and non-native speakers.

Behavioral Responses and Morphological Changes in Zebrafish Larvae (*Danio rerio*) Exposed to Microcystin-LR at Different Temperatures

Maya O'Hanlon Gjonbalaj
Advisor: Frank Scalzo

Rampant colonies of algae, known as harmful algal blooms (HABs), pose a significant threat to aquatic environments and their inhabitants. HABs may produce intracellular cyanotoxins, the most common of which is Microcystin-LR (MCLR). Previous research has documented structural and behavioral irregularities in zebrafish exposed to MCLR in crude and purified forms. However, such research has not explored the potential interaction of MCLR and temperature – an environmental determinant of HABs – on zebrafish behavior. The present study assessed whether exposure to varied concentrations of MCLR under control or elevated temperatures would induce behavioral and morphological changes in larval zebrafish. Beginning immediately post fertilization, 288 zebrafish embryos (144 per replicate) were reared at temperatures of either 28 °C or 30 °C. Twenty-four hours post fertilization (hpf), embryos were transferred to one of three MCLR exposure conditions: control (1X E3 medium), 50 µg/L, or 100 µg/L. Subjects were transferred to 1X E3 medium at 96 hpf. All subjects underwent daily structural analysis. At 120 hpf, a total of 166 subjects (replicate 1: 67) underwent two completions of a 5:5 minute light-dark cycle (20 minutes of tracking). Behavioral results indicated hyperactivity (increased distance moved and velocity) in the 30 °C 50 µg/L condition. Subjects in the 28 °C 100 µg/L, 30 °C 100 µg/L, and 30 °C 50 µg/L conditions also exhibited lateral tail bends. To the researcher's best knowledge, the present study is the first to

provide evidence of an interaction between temperature and MCLR on larval zebrafish behavior.

The Sound of Heat:
An Analysis and Review of the Theory of Thermoacoustic Sound Generation

Miles O'Rourke
Advisor: Paul Cadden-Zimansky

Thermoacoustics is a steadily growing field of study in the material sciences with conflicting mathematical models at the core. It can be found throughout nature in phenomena like volcanic vents and thunder, but its uses in consumer and medical technology are the main reason for its recent increase in popularity. In this paper, my goal was to review the conflicting models, compare them with experimental data, and look at future uses for the technology. Though unfortunately my results were inconclusive, I was able to effectively compare the models to highlight contrasting results and lay groundwork for future projects in the subject of thermoacoustics by other Bard students.

A Plant's Response to Herbivory and Disease: The Tri-trophic Interactions between Roma Tomato Plants, Tobacco Hornworms, and *Fusarium Proliferatum*

Emmett Olson
Advisor: Cathy Collins

Tomato plants are one of the most widely produced agricultural crops in the world. Amidst their agricultural success, they experience significant economic loss as a result of disease and herbivory. Some of the most prominent diseases and herbivores known to harm tomato plants are: *Fusarium D.* (disease), and tobacco hornworms (pest/herbivore). *Fusarium D.* causes wilting and stunted growth ultimately leading to plant death. Tobacco hornworms feed on the leaves, stems, and fruits of host plants, and are capable of decimating entire crop supplies. This study seeks to dissect the, largely understudied, tri-trophic interactions between tomato plants, *Fusarium D.*, and tobacco hornworms. By running a series of controlled laboratory experiments, I aimed to understand the impact of tomato infection (via *Fusarium D.*) on tobacco hornworm's eating preferences, as well as tomato plant's susceptibility to herbivory. I found that tobacco hornworms demonstrated little preference in terms of their consumption of healthy versus diseased tomato plants. Diseased plants similarly showed little to no physical differences when compared with healthy tomato plants. Interestingly, tomato plants infected with *Fusarium D.* had a higher average biomass than their healthy counterparts, following 114 days of growth. With the goal of understanding the dynamics between two of the most harmful diseases and pests in the tomato production industry, I add to the growing body of knowledge surrounding agricultural crops and their interactions with disease and herbivory.

Multiple-emitting Cyclometalated Platinum(IV) Compounds

Everest Oppenheimer
Advisor: Craig Anderson

Cyclometalated platinum(IV) compounds are of particular interest due to their unique photophysical properties such as dual emission, long excited state lifetimes, and high quantum yields when doped in PMMA film. These properties make the compounds attractive for applications in sensors, catalysis, potential light harvesting devices, and light-emitting diodes. Platinum(IV) compounds are generally understudied compared to the set of well-studied platinum(II) compounds. Our project focuses on the synthesis and characterization of Platinum(IV) compounds. Both iminic and isocyanide ligands are employed to produce six-coordinate platinum (IV) compounds. These compounds have been characterized with 1-D and 2-D NMR spectroscopy, IR spectroscopy, and single crystal X-ray diffraction. Photophysical characterization was also carried out using emission spectroscopy, lifetime measurements, UV-VIS spectroscopy, Pair distribution function analysis, and quantum yield measurements. Comparisons between the photophysical properties in solution, the solid state, and as dopants in PMMA films show significant enhancement when stabilized in PMMA films. Quantum yield values increased significantly for compounds when doped in PMMA.

Fathering from the Margins: Intersectional Invisibility, Minority Stress, Social Support, and Psychological Well-Being Among Black Queer Fathers

Christopher Paulino
Advisor: Natalie Wittlin

Black queer fathers navigate multiple stigmatized identities and experience intersecting forms of oppression such as (racism, heterosexism, and homophobia) that uniquely influence their experiences of fatherhood (Battle & Ashley, 2008).. While minority stress research has found evidence demonstrating that Black queer adults experience unique chronic stressors because of their minority statuses, little attention has been given to the social phenomenon of intersectional invisibility and how Black queer fathers as a result of their non-prototypicality may experience intersectional invisibility. This proposed study investigates the extent to which perceived intersectional invisibility, minority stress, and social support predicts the psychological well-being of Black queer fathers. Fifty participants (N=50) were asked to complete an online survey administered through the Qualtrics platform that collected information related to the variables of interest being explored. It was hypothesized that higher perceived intersectional invisibility and minority stress will predict lower psychological well-being. Additionally, social support was expected to moderate the relationship between intersectional invisibility and minority stress, such that the relationship will be weaker when social support is high. Results demonstrated that higher perceived intersectional invisibility and minority stress predicted lower psychological well being. However, social support did not moderate this relationship. Future research should consider the role of specific types of

support such as support from a significant other or from a larger community to identify whether tailored specific support from individuals is needed in order to effectively contribute to the well-being of Black queer fathers.

Comparative Study of Time–Frequency Representations and Temporal Note Construction in Automatic Monophonic Cello Transcription

Andres Perez Rangel
Advisor: Theresa Law

This study compares the impact of time–frequency representations in automatic music transcription through different note construction strategies. Three time-frequency representations (STFT, CQT, and Wavelet) were used in two transcription pipelines using 30 monophonic cello recordings.

The first pipeline (V3) is onset-driven, constructing notes from locally-detected onsets and energy decay, while the second pipeline (V5) applies temporal smoothing, stabilizing the estimation of pitch before note construction. Accuracy was measured using note-level precision, recall, and F1-score after the temporal rescaling of reference MIDI files.

Transform choice affected results only in the onset-driven pipeline, where small but consistent differences were present in the outcome of all three representations (mean F1: STFT = 0.1002, CQT = 0.0957, Wavelet = 0.1026); whereas in the temporally smoothed pipeline, all transforms produced identical transcriptions and F1-scores (mean F1 = 0.1315).

These results suggest that representation affects local segmentation, but its impact decreases when temporal continuity is enforced. In other words, accuracy in automatic music transcription depends more on note construction strategy than on time-frequency representation choice alone.

Impact of Gender Stereotypes on ADHD Symptomatology

Emily Jane Quinn
Advisor: Natalie Wittlin

In the United States, Attention-Deficit/Hyperactivity Disorder (ADHD) diagnoses have increased substantially, with notable gender differences in diagnosis and symptom presentation. For example, women are more likely to be diagnosed later in life and to exhibit predominantly inattentive symptoms, raising questions about the role of gender stereotypes in shaping ADHD expression (Ramtekkar et al., 2010). The aim of the present study was to investigate whether activating gender stereotypes influences the presentation of ADHD symptoms in men and women. A total of 253 adults with diagnosed ADHD participated in a 2 (gender: men vs. women) × 2 (stereotype salience: high vs. low) between-subjects design. These participants completed a stereotype salience manipulation, a reading comprehension task, and an ADHD state symptom questionnaire assessing inattentive and hyperactive symptoms. Results from a mixed ANOVA revealed significant main effects of symptom type and gender, with inattentive symptoms being reported at higher levels than hyperactive symptoms, and women reporting greater overall symptom severity than men. However, stereotype salience did not significantly affect symptom reporting, nor did it interact with gender or symptom type. Contrary to traditional assumptions, both men and women reported higher inattentive than hyperactive symptoms. Overall, these findings could suggest that inattentiveness is a more prominent feature of adult ADHD than previously recognized and that brief activation of gender stereotypes does not significantly impact self-reporting of ADHD symptoms.

Contraception and the Vaginal Microbiome

Sasha Rabinowitz
Advisor: Brooke Jude

Hormonal birth control supports the growth of beneficial vaginal bacteria (Tuddenham et al. 2023). However, the cause of this relationship remains largely unknown. Studies have demonstrated that hormonal birth control increases the growth of Lactobacillus species of bacteria whose dominance in the lower female genital tract is associated with decreased risk of sexually transmitted infections. With approximately 46% of reproductive aged women globally using a form of contraception, understanding how contraceptives confer other health effects to the reproductive system outside of pregnancy prevention is crucial (UN Family Planning 2022). We exposed *Lactobacillus rhamnosus* derived from a dietary probiotic tablet to birth control (Aubra EQ) commonly available through youth sexual health clinics. We determined there was no significant effect of Aubra EQ on the growth of *L. rhamnosus*. With much of the existing literature revealing increased growth of L. crispatus under hormonal contraceptive exposure, these findings suggest that this interaction is not universal across all Lactobacillus species.

The Bouba–Kiki Effect:
Testing Implicit Sound Symbolism in a Reaction Time Task

Polina Rafailova

Advisor: Grace deMeurisse

Sound symbolism is present in human language in more ways than we think, helping humans learn and use language more efficiently. However, it remains unclear whether humans show an implicit preference towards sound-symbolic mappings. We tested whether the sensitivity to the Bouba–Kiki effect—the tendency to match round or spiky shapes to certain speech sounds—would extend to a Reaction Time congruency paradigm. The congruency effect emerged only for round sound-shape mappings, consistent with previous studies finding a stronger effect for the bouba-like stimuli. Furthermore, only vowels appeared to influence sensitivity to sound symbolism. This work suggests a revision of the current methodological and theoretical understanding of the Bouba–Kiki effect.

A Human In The Loop Alpha Generation

Rose Rahimi

Advisors: Valerie Barr & Emanuele Citera

We extend Vuletic et al.'s FinGAN framework for forecasting ETF excess returns of S&P 500 stocks. The thesis contributes four elements: a modular TensorFlow reimplementation of the original PyTorch codebase; an architectural extension, FinTimeGAN, that introduces a TimeGAN style Embedder Recovery pair to run the adversarial game in a learned latent space; an independent branch loss training protocol that resolves a discrepancy between Vuletic's published algorithm and her reference implementation; and an empirical comparison of input return representations.

Models are evaluated on a 28 stock single name universe spanning nine GICS sectors, and on a Vuletic comparable universe of 22 stocks and 9 sector ETFs. The evaluation framework separates model selection (by validation Sharpe), statistical significance gating (a portfolio level 200 permutation test), and distributional sanity gating (collapse flags) into three independent axes, and reports per ticker results descriptively rather than as binary verdicts.

On the 28 stock universe, FinGAN achieves a portfolio weighted signal Sharpe of +2.022 at $p < 10^{-4}$, exceeding the ARIMA(2,0,2) baseline at +0.642 and the Ridge AR(10) baseline at +0.227. On the Vuletic comparable universe, FinGAN reaches a portfolio Sharpe of +3.17, surpassing the best result reported by Vuletic et al. on the same universe. Cross sectional analysis indicates that the gains from generative modeling come from

amplifying existing signals in defensive and utility stocks rather than from extracting signals where linear baselines fail.

Perceptual Load & Working Memory

Aijah Ariel Reese

Advisor: Thomas Hutcheon

Perceptual Load Theory is a field within psychology that concerns itself with attentional capacity, furthermore how an individual person processes distractors based on the attentional demands in their perception. This experiment builds upon pre-existing research that found that perceptual load tasks were correlated with less distractor processing when the task was greater in difficulty compared to higher distractor processing when tasks were easier in difficulty. To further this finding and strengthen perceptual load theory based on previous critiques, the experiment conducted here implemented a dual-task paradigm, with a memory task in conjunction with a typical target search task with four separate conditions. Relying on previous research centering how emotional stimuli may impact performance, this study implemented three ranges of emotions across four varying faces along with a search array task varying in difficulty based on easy and hard. The hypothesis was that due to the demands on attention between both tasks, one would take prioritization over the other and result in poor performance, with the memory task having favor due to its early onset compared to the search array. Ultimately, repeated measures Analysis of Variances indicated that difficulty and the congruency of the perceptual load had separate interactions with the target search task, supporting previous research stating that participants were slower to react for hard tasks. When assessing correct and incorrect accuracy on the facial distractor task, when participants maintained the faces in working memory the search array task was not significantly negatively impacted. These results corroborate previous research that increased perceptual load lends to less distractor

interference, in addition to factoring in working memory and whether it negatively or positively influences performance during perceptual tasks.

Investigating the Impact of Host Plant, Environment, and Phylogeny on Morphological Variation Across Annual Cicada Species

McKenna Reeves
Advisor: Alyssa Hernandez

Annual cicadas (Family Cicadidae) are plant-feeding insects that can be found across biogeographies in North America. While there has been a lot of research into periodical cicadas, which live underground for 13 or 17 years, we do not have a strong understanding of the specific biology of over 160 North American annual cicadas species, which live underground for 2-5 years. Compared to their periodical forest-isolated counterparts, annual cicadas are known for feeding on different types of host plants depending on what environment they are emerging from. While it is known that insect morphological traits are highly specialized according to their feeding strategies, there has not been evidence that has linked cicada morphology to host plants. I studied seven species of North American annual cicadas and one periodical by imaging specimens, creating Z-stacks, and analyzing morphological variance with Principal Component Analysis (PCA) and pair-wise associations, with an emphasis on external mouthpart morphology. There was variation between species primarily in body size, mouth parts, and leg variation. Body size was the largest decider of variation between species and geography. The grass hosted species were significantly smaller than all other species, and hardwood hosted species were consistently the largest. Current phylogenetic relationships did not explain the observed variance. The environment was likely too broad to show meaningful variation, but host plants should be investigated for future

morphological analysis, including shape analysis and between more closely related species.

Knot or Not?
Identifying Knots of Front Multicrossing Number Two

Maya Remick

Advisor: Caitlin Leverson

A smooth mathematical knot is a non self-intersecting closed loop of string. Knots can be generalized to links, which are a collection of one or more non self-intersecting closed loops of string that may be intertwined with each other. A Legendrian knot is a knot that satisfies certain geometric properties in the space it inhabits. We can find Legendrian representatives that satisfy these geometric properties for all smooth knots. Last spring, Josh Krienke defined a new knot invariant, the front multicrossing number, as the minimal number of multicrossings in the front projection of a Legendrian representative of a smooth knot. Previous research by Kumar, Murphy, and Naff shows that all Legendrian knots with a front projection with one multicrossing are smoothly the unknot, a simple circle. Building off of this work, Krienke classified all links of front multicrossing number two. In this paper we work towards reducing this classification of links to a classification of knots by identifying cases that will always produce multi-component links and identifying a number of smooth knots of front multicrossing number two. This work progresses the full classification of all knots with front multicrossing number two and provides strong evidence towards the existence of knots with front multicrossing number three. This in turn broadens the significance of the front multicrossing number beyond its current ability to distinguish the unknot and therefore establishes it as a more effective knot invariant in its ability to distinguish between different knots.

Hispanics' and Latinos' Attitudes Towards Therapy

Jeremy Rojas
Advisor: Natalie Wittlin

Latinos and Hispanics face barriers around seeking out mental health assistance and have reported underutilization of professional mental health services (American Psychiatric Association, APA., 2011). Cultural norms and stereotypes around mental illnesses are two of the barriers that are affecting this community. To examine whether altering social norms and stereotypes around mental illness will increase positive attitudes towards seeking mental health assistance, I presented Latino and Hispanic young adults (N=177) with a New York Times article in which they are either told that seeking therapy is Normative/ Non-normative within the Latino or Hispanic communities and seeking therapy is something strong/weak individuals do. Additionally, participants were asked to report how important being Latino or Hispanic is to their identity. I found that Latinos and Hispanics reported positive attitudes towards seeking mental health assistance across all conditions. Furthermore, I also found a correlation between high identity importance and positive attitudes towards seeking mental health assistance. This study demonstrated that even when presented with social norms that go against help seeking behaviors and stereotypes around mental illness Latino and Hispanic youth still report positive attitudes towards seeking mental health services.

Design and Characterization of Ruthenium Complexes for Anti-Cancer Applications

Alleisha Romain

Advisor: Craig Anderson

This study explores the synthesis and characterization of Ruthenium-Arene complexes, incorporating phenformin in an aim to contribute to the development of new anti-cancer therapeutics. To investigate the properties and potential synergistic effects of metal–ligand combinations, spectroscopic methodologies were employed. UV–Vis spectroscopy was used to 1) assess inhibition of the DHFR enzyme by our dinuclear Ru compound; 2) The ruthenium(II) compound's reactivity properties were probed by monitoring its reactions with imidazole & histamine. Syntheses of mannose derivatives were attempted.

Salt & Heat:
Unraveling the Scientific and Social Lives of Cyanobacterial Blooms

Selina Royer
Advisor: Ellie Diamant

Cyanobacterial harmful algal blooms (cHABs) are increasingly recognized as a global environmental concern affecting both marine and freshwater systems. Rising temperatures and freshwater salinization driven by climate change and landscape influences have complex effects on algal growth. However, the interactions between them are not yet fully understood. In this study, algal cultures of *Anabaena* were exposed to different temperatures and salinity treatments to assess their effects on algal growth rates. Low temperature showed a marginally significant negative effect on growth, while ocean salinity had no detectable impact. In contrast, salt wedge salinity significantly stimulated growth. The interaction effects revealed that the growth-stimulating impact of intermediate salt wedge level was reduced under low temperature conditions. This indicates *Anabaena's* response to salinity is temperature-dependent, with optimal growth occurring at moderate salinity only when temperatures are warm. Model comparisons confirmed that both temperature and salinity independently improved the fit, but their interaction was not significant when all salinity treatments were considered together. These findings support that algal growth responds differently to specific salinites depending on temperature. Overall, these results emphasize

the importance of evaluating environmental factors in combination rather than isolation for future research on bloom dynamics.

Contraceptive Empowerment: Exploring Contraceptive Counseling Quality, Medical Mistrust and Online Health Information

Scout Saavedra Weisenhaus
Advisor: Sarah Dunphy-Lelii

This study explored the relationship between perceived quality of contraceptive care, medical mistrust, and the use of social media for contraceptive information. Participants were recruited online and included individuals aged 18–35 who identified as female and had consulted a clinician regarding contraception within the previous 12 months. Participants completed the Quality of Contraceptive Counselling scale (QCC) (Holt et al., 2018), the Medical Mistrust Index (MMI) (LaVeist et al., 2009), and the Contraceptive Information on Social Media (CISM) index, a three-item measure developed for this study to assess use of, trust in, and attitudes toward social media as a source of contraceptive information. It was hypothesised that MMI scores would be negatively correlated with QCC scores (H1), that MMI scores would be associated with CISM responses (H2), that QCC scores would be associated with CISM responses with directionality moderated by MMI scores (H3), and that MMI would moderate the relationship between CISM responses and QCC scores (H4). Results supported H1, such that higher medical mistrust was associated with lower perceived quality of contraceptive care. No subsequent hypotheses were supported. These findings contribute to current understanding of the factors relevant to satisfactory contraceptive care, particularly in the

context of increasing social media use as a source of health information.

Investigating the Effects of Malnutrition on Child Development and Their Susceptibility to Antibiotics Using Zebrafish (*Danio rerio*) as a Model Organism

Sayed Zubair Sadat
Advisor: Gabriel Perron

Malnutrition can alter body functions and disrupt the gut microbiome, which influences how organisms respond to diseases and antibiotics. Despite the fact that there were many previous studies conducted on the effect of diet and diseases on adults, studies on child malnutrition and their susceptibility to antibiotics are still lacking. We hypothesized that dietary imbalance would increase susceptibility to antibiotics, particularly during early developmental stages. In this study, we investigated the effects of diet and antibiotics on zebrafish (*Danio rerio*). The diet assay was performed on 96 larval fish across three diet groups, divided by food source: control, low-fat, and high-fat. The antibiotic exposure assay was performed using the static immersion technique on 25 late juvenile zebrafish for 7 days with streptomycin sulfate, a reagent widely used in aquaculture research and for quality control in clinical laboratories. The diet assay on the larval zebrafish showed rapid mortality and was statistically significant (log-rank test, $p < 0.0001$). However, the effect of diet on late-juvenile zebrafish was not statistically significant (log-rank test, $p > 0.05$). The effect of diet on late juvenile zebrafish showed lower mortality across all treatment groups compared to the control group; additionally, higher antibiotic doses were associated with slightly higher survival rates in treated groups compared to the untreated groups. Using qPCR, we analyzed microbial composition and host response, observing significant changes in the microbiome. We observed a significant relationship between diet and antibiotic exposure.

Overall, our findings suggest that poor nutrition can affect how antibiotics work in the body, and this information is important for understanding global health problems, especially in places where malnutrition is common.

On the Frequency of Kodaira-Néron Types Among Elliptic Curves with *j*-invariants 0 and 1728

Sebastian Sargenti
Advisor: John Cullinan

In this project, we compute the asymptotic distribution of Kodaira-Néron types for elliptic curves over Q with *j*-invariants 0 and 1728. In the former case, we condition on torsion structure, extending work of Barrios and Roy by treating the case of trivial torsion. In the latter case, we condition on isogeny class size.

Temperature and Moisture Shape Soil Fungal Effects on Seed Germination

Brenden Schaaf
Advisor: Cathy Collins

Soil-borne fungi are diverse and dynamic components of soil communities, driving key microbial and biochemical processes. Among their many roles, some soil fungi act as agents of seed and seedling mortality. At the same time, soils serve as seed banks, storing viable, yet dormant seeds that can germinate in future years. These soil seed banks serve as genetic reservoirs, allowing plant communities to recover and reassemble after disturbance. As a result, fungal attacks on seeds within soils can strongly influence plant population dynamics, community composition, and agricultural productivity. Because warming and shifts in precipitation are generally expected to accelerate fungal growth, it is often assumed that climate change will increase fungal pathogenicity and seed mortality.

In this experiment, I tested how changes in temperature and moisture associated with climate extremes alter the pathogenicity and host range of the soil-borne fungus *Alternaria angustiovoidea* across six American meadowland seed species. In a growth chamber experiment, I sowed seeds in soils inoculated with *A. angustiovoidea* and in uninoculated controls under two temperature conditions (cool: 22 °C and warm: 27 °C), crossed with three watering regimens (low, medium, and high) to simulate a range of moisture levels. *A. angustiovoidea* had its strongest effects in cool treatment groups, while showing little to no effect on seed germination at warmer temperatures. Contrary to my initial hypothesis that warmer and wetter conditions would increase disease severity and seed mortality, association with *A. angustiovoidea* improved germination for some species and reduced

it for others by more than 10% across moisture treatments, with the strongest effects occurring in the cool chamber under high-moisture conditions. These results show that temperature and moisture jointly shape whether a widespread soil fungus may act as a pathogen or mutualist at the seed stage, complicating expectations that climate warming will uniformly intensify fungal damage to seeds in soils.

Between Tongues:
Emotional Recollection and the Limits of Translation Across Chinese–English and German–English Bilinguals

Sofia Belle Schuhbeck
Advisor: Sarah Dunphy-Lelii

This study explores how the frequency of emotional expression in autobiographical memories is affected when compared across native and non-native languages, focusing on Chinese–English and German–English bilinguals. Building on foundational research in psycholinguistics and translation studies, my project questions the notion of language as a mere vehicle for expression, and probes the extent to which language influences one's frequency/tendency of emotional expression itself. Prior research suggests that memory recall is often more vivid and emotionally vibrant when expressed in the language of encoding (usually one's native language), while translation introduces interpretive and culturally embedded shifts in meaning. Using a mixed-methods design, participants (N = 19) each produced 4 written narratives, recalling their experiences of joy and shame, produced in both their native language and in English. Native-language narratives were translated into English using Google Translate, and all narratives were subsequently coded for positive emotion terms, negative emotion terms, and emotional intensifiers. These frequencies were analyzed as ratios relative to the total word count of each narrative, alongside prosocial behavior scores from the Strengths and Difficulties Questionnaire (SDQ). Contrary to my initial hypotheses, no significant between-group differences emerged in overall emotion term ratios. However, strong within-participant consistency across languages, particularly for shame, suggests that emotional expression and form may persist despite linguistic

shifts. Cultural patterns were not reflected in mere quantity of emotion terms, but rather in consistency and contextual framing. Overall, my findings suggest that emotional expression across native and non-native languages does not fundamentally reduce or inhibit the frequency of emotion terms use, but rather reflects and reorganizes expressive form within linguistic and cultural contexts.

Queer Adolescence Online

Julia Seaver

Advisors: Sarah Dunphy-Lelii & Stephen Graham

This study examined the retrospective perceptions of social media's impact on the wellbeing of queer adolescents during 7th and 8th grade. Eighty-eight participants ages 20–24 completed an online survey assessing social media use, offline and online support, marginalization, and an overall rating of social media's net effect on their wellbeing. Neither online nor offline support independently predicted wellbeing, though further analyses suggested that the combination of both support types was associated with the most positive outcomes. The majority of participants reported both positive and negative effects of social media. Qualitative responses highlighted direct support from queer individuals, community, and learning as primary positive effects. Findings are discussed in the context of the rapidly shifting social, legal, and political landscape facing queer youth.

Predicting and Classifying Anemia Types Using Supervised Machine Learning: A Comparative Study of SVM, Decision Tree, Random Forest, and a Voting Ensemble Method

Masoma Shoayb

Advisor: Jordan Ayala

Anemia remains a significant public health challenge in resource-limited areas where diagnostic infrastructure is scarce. This study evaluates four supervised machine learning algorithms to determine their effectiveness in classifying anemia types using hematological parameters. Support Vector Machine, Decision Tree, Random Forest, and a Voting Ensemble method combining Support Vector Machine and Decision Tree were compared to identify which approach achieves the highest classification accuracy. Models were evaluated using accuracy, precision, recall, F1-score, and confusion matrices to ensure comprehensive performance assessment. The comparative analysis demonstrated that ensemble methods consistently outperformed individual classifiers, with Random Forest achieving the highest accuracy (88%), followed by the Voting Ensemble (86%). Both ensemble approaches significantly surpassed the performance of Support Vector Machine and Decision Tree alone. These findings confirm that machine learning models can effectively differentiate between anemia types based on routine blood test data, which can provide practical guidance for healthcare organizations seeking to implement automated diagnostic support systems. The results show that ensemble algorithms can accurately classify anemia from standard hematological data and offer a practical alternative where access to specialized clinical expertise is limited.

Battling the Bark Beetle: Relationships between Soil Fungi, Soil Nutrients, and Beech Bark Disease

Izzy Simon
Advisor: Cathy Collins

Fagus grandifolia, the American Beech tree, has suffered from Beech Bark Disease (BBD) since the mid-19th century. In the past 20 years, disease rates have significantly increased in North America. BBD results from the interaction of the insect *Cryptococcus fagisuga* and the fungi *Neonectria faginata*. The disease has three stages: the advance front, when *C. fagisuga* first appears as small, white, waxy dots along the tree; the killing front, when *N. faginata* infects the tree and large cankers form; and the aftermath, when the interaction of the two organisms lead to the death of a tree. In addition to fungal pathogens found in plant tissues, soil microbial fungi also interact with trees. Some soil fungi help trees obtain nutrients, and may protect plants from disease. Previous studies have documented the negative effect of BBD on *F. grandifolia*, and the net positive effect of soil fungi on tree health. However, whether the presence and/or severity of BBD has an impact on trees remains unclear. In my study, I seek to discover if infection rate of BBD for *F. grandifolia* is associated with compositional shifts in soil fungal communities. To address this question, I will assign a level of infection (1-10) for trees. I will sample soil fungi at the base of trees with varying levels of infection to test the hypothesis that microbial communities shift with tree infection status.

Prime Patterns of Bernoulli Denominators

Niko Singband
Advisor: John Cullinan

The Bernoulli numbers have been known since they were described by Jakob Bernoulli and Seki Takakazu in 1713 and 1712. Our research identifies patterns within the numerators and denominators of Bernoulli numbers, building upon the work of Von Staudt and Clausen, Rado, and Erdős and Wagstaff. Using the computer algebra system PariGP to test conjectures and an explicit formula for generating individual Bernoulli numbers, our work has resulted in a theorem which allows for the denominator of any even-indexed Bernoulli number to be predicted based on its index without needing to directly calculate the Bernoulli number. With this result, we can sieve for any specific Bernoulli denominator value. This is exciting as the proportion of Bernoulli denominators that equal 6 is an open question. Given a properly constructed sieve, we can calculate a more accurate estimate for the proportion of Bernoulli numbers with a denominator equal to 6.

Comparative Analysis of *E. coli* Growth on Fermented and Heat-Cured Deli Meats Nutrient-Rich Environments

Benjamin Steketee
Advisor: Gabriel Perron

Foodborne illness as a result of Ready-to-Eat (RTE) meat contamination is a constant public health concern, so understanding the effectiveness of product preservation techniques across environmental conditions is important for food safety. Focusing on fermented salami and heat-cured ham, this study highlights that product preservation may not provide strong *Escherichia (E.) Coli* growth resistance under nutrient dense conditions. The results of a controlled contamination experiment on ham and salami slices revealed no difference in initial *E. coli* bacterial load, nor following six hours of incubation at 37°C. However, time did have a significant effect on bacterial growth in both products, indicating the importance of proper deli meat storage conditions regardless of preservation style. While the active antimicrobial activity from lactic acid bacteria on fermented salami is likely stronger suited for managing post-processing pathogenic bacterial exposure than the salt and nitrate preservation of heat-cured ham, the complex nutrient base of lysogeny broth may provide *E. coli* ample resources to adapt to and overcome the resistance factors regardless of preservation technique. This signifies the necessity of proper product handling, especially in post-processing environments, to improve RTE meat safety outcomes.

Lotic Macroinvertebrate Response to Wastewater in the Saw Kill

Marisol Thompson
Advisor: Felicia Keesing

Lotic macroinvertebrate distribution is, in part, related to their sensitivity to anthropogenic environmental stressors. This project consisted of both a field sampling survey and a laboratory study in the interest of determining lotic macroinvertebrate response to the wastewater being drained from Bard College's Wastewater Treatment Plant into the Saw Kill. The field survey consisted of collecting artificial substrate samples from above and below this effluent site and comparing the taxa represented and their abundance. While no statistically significant results were found, there were observable trends in abundance in Trichoptera, Ephemeroptera, Amphipoda, and Gastropoda which would be worth pursuing further. The laboratory study consisted of treating *Enallagma*, *Physa*, and unspecified amphipods to water from above or below effluent from the Saw Kill. Feeding and activity scores were documented for the *Enallagma*, and survival scores for the *Physa* and amphipods. There were not significant results for either *Physa* or amphipods, but there was a difference between treatments for *Enallagma* feeding scores, with the above-effluent group scoring higher. These results suggest the need for more research and updated methods.

Evolution of Antifungal Cross-Resistance from Agricultural to Clinical Drugs in *Saccharomyces paradoxus*

Myreen Toledo
Advisor: Robert Todd

Fungal infections are an urgent threat to global public health and agriculture. Due to global warming and growing pressure on food supply networks, the range and diversity of fungal pathogens is expected to expand in both of these important sectors. Currently, there are only a few families of antifungal drugs available to prevent fungal infections, and the incidence of drug resistance is on the rise both in the clinic and on farms. Therefore we ask, does the exposure of agricultural antifungals lead to cross-resistance in wild yeast isolates to clinical antifungal drugs and, if so, what are the evolutionary mechanisms that drive this cross-resistance? In this study, I propose to determine if environmental isolates of the yeast species, *Saccharomyces paradoxus*, become cross-resistant to clinical antifungals when exposed to agricultural antifungal drugs by observing shifts in minimum inhibitory concentrations (MIC) on yeast strains evolved in different drug backgrounds, and to identify potential genetic drivers of cross-resistance utilizing technologies like Yeast Analysis Mapping Pipeline (YMAP) to look for any underlying chromosomal-level changes. I find that there seems to be resistance to a clinical antifungal (fluconazole) in yeast when exposed previously to an environmental antifungal (imazalil) and vice versa. Additionally, I observe a chromosome amplification present on the drug-evolved yeast isolates that is not present on the control yeast isolate that could potentially be linked to an evolutionarily acquired resistance mechanism.

Measuring the Role of Relationships and Effect of a Contact-Based Intervention on Stigmatization of People with Schizophrenia

Evelyn Urist
Advisor: Thomas Hutcheon

Stigmatization of people with schizophrenia is often driven by perceived dangerousness, despite evidence challenging this belief. Prior research suggests that contact and interpersonal relationships may reduce stigma, but less is known about how relationship closeness and brief contact-based interventions influence both implicit and explicit attitudes. The present study examined whether a short, contact-based intervention and prior relationships with people diagnosed with schizophrenia affect stigmatization. Participants (N = 50) were randomly assigned to a contact or no-contact condition and completed measures of explicit stigma (Social Distance Scale) and implicit stigma (Implicit Association Test). The intervention produced a marginal reduction in explicit stigma but did not significantly affect implicit stigma. Relationship presence was not significant; however, greater relationship closeness was associated with lower implicit stigma at the statistically significant level. These findings support the relevance of previous relationships in stigma, as well as the future use of contact-based interventions.

Treated as Children, Successful as Adults? Assessing the Lifelong Impacts of Childhood Therapies and Medications through Adult Measures of Success

Eli Wallace
Advisor: Anne O'Dwyer

The rates of psychological diagnoses and treatments are rising—this is true not only for adults, but also for children and adolescents. However, there is little published research on the long-term outcomes of psychological treatments, both medications and talk therapies. Most research focuses on short-term outcomes and symptom reduction, rather than life satisfaction and long-term wellbeing. In this study proposal, I begin with a historical review of medications as treatment for psychological distress, particularly for children and adolescents. I then briefly describe various talking therapies and their histories. In considering long-term outcomes, I draw from positive psychology to explore the notion of subjective wellbeing as central to these outcomes. The proposed study begins with an online survey asking adults who experienced psychological treatment as children or adolescents to both evaluate and describe their treatments—how they believe they were affected long-term, and answer a brief wellbeing questionnaire. The conclusion highlights the limits of the proposed study, but also the value of this type of research and the importance of shifting our focus from short-term to long-term in considering treatments.

Experiences of Healing with Psychedelics: A Thematic Analysis

Karen A. Waltuch
Advisor: Elena Kim

This study investigates the client-centered felt experiences of individuals who have engaged in Psychedelic-Assisted Therapy (PAT). The qualitative research engages in Thematic Analysis from a constructivist approach in order to better understand the experiences of individuals who have used this therapy modality in the past, and to uncover what successes or/and challenges they felt resulted from it. One-on-one interviews were conducted with seven individuals who had both extralegal and aboveground therapeutic experiences with substances including MDMA and ketamine. Their interviews were transcribed, coded, categorized, analyzed, and used to generate four themes pertaining to agency, relationality, language, and sense-making as important components of the PAT experience. This research seeks to expound upon current quantitative research that omits experiential nuances from the narratives of individuals engaged in PAT.

Clouds and the Discrete Inscribed Square Problem

Shosha Wheeler
Advisor: Ethan Bloch

Do all continuous simple closed curves contain four points which are the vertices of a square? While the general question remains open, it has been proven that such squares must exist for a broad class of sufficiently nice curves. We are concerned with the question as it pertains to curves in the discrete setting called lattice curves, which consist of points in the two-dimensional integer lattice. The existing proof that every simple closed lattice curve has an inscribed square relies on the proof of the analogous theorem for polygons in R2. The motivation of this project is to develop a proof using only discrete methods. We examine a curve's cloud, defined as the set of all the points that complete an inscribed half-square of the curve. The 8-connectedness of the cloud offers a new route to proving the discrete inscribed square problem. We find that the cloud is not always 8-connected, and as such investigate the distinct 8-connected components of the cloud. Cloud components are distinguished foremost by their empty or nonempty intersection with the lattice curve (termed extraneous and critical, respectively), and further according to two notions of size: weight and spread. We establish bounds on the sizes of inscribed half-squares and proximity of cloud points to their originating inscribed half-square. We prove that there exist lattice curves whose clouds have arbitrarily many components while having only one critical component, and also of lattice curves whose clouds have arbitrarily many critical components.

Phrag out! Seedling Emergence and Diversity as a Function of Proximity to *Phragmites australis* and *Typha latifolia* Monotypic Stands

Aidan Wiese
Advisor: Felicia Keesing

Invasive species are well-known for their potential ability to supersede native species, effectively outcompeting for space, sunlight, and water. *Phragmites australis*, an introduced species from Eurasia, is extensively documented as a significant ecological threat for wetland and grassland ecosystems across the U.S. and Canada, and is often observed growing in dense monotypic stands in a variety of habitats. I analyzed the seedbank of soil samples to determine whether *P. australis* inhibits seedling germination of other plants, and how it may contribute to lower diversity in areas it colonizes. I used the Broadleaf cattail *Typha latifolia*, a native wetland plant with similar mechanisms of dispersal, as a point of comparison. Both *T.latifolia* and *P. australis* form dense monotypic stands, which often dominate the above ground vegetation in the habitats they inhabit. Using a growth chamber, I conducted two experiments, germinating collected soil cores under cold-stratified and non-stratified conditions. By analyzing the seedling composition of soil immediately inside and outside of stands of each plant, I attempted to quantify the effects of vegetation type (*Typha* versus *Phragmites*) and location relative to stand (interior versus exterior) on seedling emergence and diversity. Although my results produced no significant effect on abundance or diversity, I found that exterior plots tended towards higher richness under cold-stratified conditions, regardless of vegetation type.

Drawing Connection:
Does Mimicry During a Drawing Task Increase Empathy and Prosociality?

Rebecca Wintjen
Advisor: Natalie Wittlin

Mimicry—the unconscious, or conscious, imitation of another person's behaviors, gestures, or speech patterns during social interaction—causes empathy, or the capacity to understand or share another person's emotional experience, and prosocial behavior, or any helping behavior that does not directly benefit the person doing it. Drawing is used as a form of communication and, when mimicked, may act as a social behavior like speaking or mannerisms. The aim of this study is to explore the effect of mimicry of participant drawings on prosocial behavior and state empathy. Participants were randomly assigned to mimic the researcher while drawing, get mimicked while drawing, or draw on their own. Participants were asked a prosocial question to get the researcher a cup of coffee and take a state empathy questionnaire. There was no effect of mimicry on prosociality, but there was an effect of being mimicked on state empathy. Participants who were mimicked showed greater state empathy towards the researcher than in the other two conditions. Thus, mimicry of drawing has an effect on how much state empathy someone experiences towards the mimicker.

Playing Flow Free Game on Hexagonal Grid Graphs and Polyhedron Graphs

Minshi Yang
Advisor: Steven Simon

This project explores Flow Free game on hexagonal grid graphs and polyhedral graphs. A basic Flow Free game is a puzzle game in which the player is presented with an $n \times n$ square grid, containing pairs of colored points. To solve the puzzle, the player needs to find paths connecting points of the same color so that no path intersects and the paths cover all of the squares in the grid. Here we consider variants of this game for triangular tilings and the surfaces of Platonic solids. This reduces to finding Hamiltonian paths in hexagonal graphs and polyhedral graphs.

Video Game Optimization: Window-based imposter for LOD

Tris Yang

Advisor: Theresa Law

Polygon-based video games have come a long way since the mid 90s. Nowadays, developers use game engines such as Unity, Unreal Engine, Godot, etc., to make various 3D and 2D video games. Typically in 3D games, fancy visuals require more computation power as more complex objects are being rendered. This led to a demand for faster processors which normal consumers might not be able to afford. This prompted a few developers to optimize while others shift their focus towards working on faster hardwares. There have been many optimization methods proposed by many experts. The project attempted a method where instead of rendering objects from far distances, a concept of Image-Based Rendering or Imposter was used by replacing those distant spaces with an image that dynamically changes based on the character position. However, the more dynamic the change is, the more memory usage there will be as more pictures are loaded into the memory. Hence, the project proposes an extension to this technique which, in itself already uses an extremely low amount of pictures, by adding a deterministic model which will try to determine what pictures should be loaded into the memory and what should not be. The experimental result showed that the normal imposter version reduced computational load and increased FPS about 20%. However, statistical analysis from user feedback concluded that there was no important difference in perceived experience. This suggested that improvement in technical performance doesn't always equate to better perceived experience.

Predicting Recidivism within the Criminal Justice System using Machine Learning Algorithms

Karla Zarate

Advisor: Kerri-Ann Norton

In this project, I examine the use of machine learning and criminal justice, focusing on predicting recidivism. Using data from the National Institute of Justice, I developed and evaluated multiple logistic regression models to understand how different factors, including demographics, criminal history, supervision conditions, and post release behavior, contribute to forecasting. The findings show that while combining these variables improves predictive performance, overall accuracy remains moderate and declines over time. These results highlight the potential and limitations of predictive modeling in this context. While machine learning can provide useful insights, recidivism remains difficult to predict, raising important questions about fairness, bias, and the ethical use of models in decision making.