Arkansas STEM Posters @ the Capitol

"It is essential, if we want to continue to reap the benefits of science, to commit as a nation to preparing more young people for extraordinary careers in science."

—*Carol W. Greider, 2009 Nobel laureate in physiology & medicine*

March 4, 2026

Highlights

- **102 students**
- **From 13 Arkansas colleges and universities**
- **Presenting 72 different presentations of original work**
- **Encompassing all aspects of science and technology**

STATE ARKANSAS STATE UNIVERSITY

UNIVERSITY OF ARKANSAS

HENDERSON STATE UNIVERSITY

OUACHITA BAPTIST UNIVERSITY

HENDRIX

ARKANSAS TECH UNIVERSITY

UNIVERSITY OF CENTRAL ARKANSAS

UALR UNIVERSITY OF ARKANSAS AT LITTLE ROCK

UNIVERSITY of ARKANSAS AT PINE BLUFF 1873

UAM THE UNIVERSITY OF ARKANSAS AT MONTICELLO Monticello · Crossett · McGehee

LYON COLLEGE

JOHN BROWN UNIVERSITY

CENTRAL BAPTIST COLLEGE

PHILANDER SMITH COLLEGE EST 1877

UAFS UNIVERSITY OF ARKANSAS FORT SMITH

UAMS UNIVERSITY OF ARKANSAS FOR MEDICAL SCIENCES

SAU SOUTHERN ARKANSAS UNIVERSITY

HARDING UNIVERSITY

ARKANSAS STEM POSTERS @ the Capitol

Student presenter (school) ….. page with abstract

Exploring Cytoskeletal Regulation of Mitochondrial Dynamics in Dictyostelium discoideum

Jesus Hernandez Meza *[Mentor: K. Naylor]*

University of Central Arkansas - Biology

Mitochondrial dynamics—including fission, fusion, and motility—are essential for cellular homeostasis, and their dysregulation is linked to neurodegenerative diseases. In Arkansas, Parkinson's and Alzheimer's diseases affect 66,500 individuals, according to UAMS and Alzheimer's Association data. Dictyostelium discoideum serves as a valuable model for investigating mitochondrial regulation, particularly the role of the cytoskeleton. To examine cytoskeletal contributions, microtubules were disrupted using nocodazole and actin filaments with latrunculin B, and resulting changes in mitochondrial dynamics were analyzed. Nocodazole treatment reduced both fission and fusion rates, with a significant decrease in fusion, and induced mitochondrial clustering and shortening. Spatial analyses revealed no distance-dependent effects on fission relative to microtubules; however, fusion events were significantly altered based on proximity, indicating a key role for microtubules in fusion regulation. In contrast, latrunculin B significantly decreased fission and fusion rates and increased the prevalence of large, rounded, and irregularly shaped mitochondria. Loss of actin also altered fission and fusion as a function of distance from microtubules, suggesting cytoskeletal crosstalk. These findings demonstrate that microtubules and actin differentially regulate mitochondrial dynamics in Dictyostelium, providing insight into conserved mechanisms relevant to neurodegenerative disease pathology.

Comparing Leucocytes Between Captive and Wild-Caught Nerodia Rhombifer

Macey Powell and Natalie Haydt *[Mentor: L. Neuman-Lee]*

Arkansas State University - Biology

Reptiles emphasize innate immune responses, making them valuable models for studying innate immunity. Despite their potential for immune research, little research has examined immune function in reptiles, making it necessary to find suitable study models. Watersnakes (Nerodia rhombifer) are an ideal candidate model species for immune research due to their natural abundance and large body sizes. The resulting large blood volume enables accurate identification and quantification of leukocyte populations using flow cytometry, a first step in establishing a model organism. In addition to establishing leukocyte populations in wild watersnakes, it is critical to demonstrate how captivity may influence leukocyte populations. To assess immune function in captive watersnakes, we performed flow cytometry on blood samples from wild-caught and captive Nerodia rhombifer in Northeast Arkansas and compared leukocyte population sizes. Using flow cytometry, we quantified and compared lymphocytes, heterophils, and azurophils. Comparing leukocytes between captive and non-captive watersnakes can shed light on whether captivity induces a chronic stress response that affects immune function. This research will help researchers understand the impact of captivity on immune function in captive Nerodia rhombifer while also establishing a baseline model for reptilian immunity that can be used for comparative studies across species.

Exploring the Function of DJ-1 Protein in Mitochondrial Dynamics in Dictyostelium discoideum

Martin Ugarte Ferrin *[Mentor: K. Naylor]*

University of Central Arkansas - Biology

Mitochondrial dysfunction plays a role in the progression of Parkinson's Disease (PD), affecting 6,500 Arkansans. Mitochondrial dysfunction depends on mitochondrial dynamics, thus understanding fission, fusion, and motility is key to finding PD treatment. Past studies suggest insufficient fission can cause a tangle of interconnected mitochondria and insufficient fusion can cause mitochondrial aggregates, leading to a decrease in motility and might contribute to the loss of mitochondrial function. Rates of fission, fusion, and motility are being determined when overexpressing and under-expressing DJ-1 in our model organism, Dictyostelium discoideum. Mutations in DJ-1 are known to cause PD and are involved in mitochondrial function, yet its function is poorly understood. Results from this study will help clarify DJ-1's function and the relationship between mitochondrial dynamics, dysfunction and PD.

PD conditions were induced with rotenone, and mitochondria were stained for visualization by confocal microscopy. Analysis of fission and fusion of knockdown and overexpressed DJ-1 strains showed that DJ-1 decrease alone does not affect fusion and fission but there is a synergistic effect when DJ-1 levels decreased and cells were exposed to oxidative stress via rotenone. In contrast, increasing DJ-1 levels and rotenone exposure suggests that oxidative stress is reduced, with fusion and fission events resuming normal values. These results suggest that DJ-1 might protect against PD.

Cinnamic Acid Modulates Iron Deficiency Responses in Soybean Through Improved Phenotypic Performance and Regulation of Iron Homeostasis-Related Genes

Ruby Bagchi *[Mentor: H. L. Wang]*

University of Arkansas—Little Rock - Biology

Iron (Fe) deficiency reduces soybean productivity by causing chlorosis and reducing plant growth development. Cinnamic acid, a phenolic compound, affects nutrient availability and plant stress responses, but the role of cinnamic acid on iron deficiency is poorly understood. This study examined how cinnamic acid influences phenotypic traits and molecular responses in soybeans under iron-deficient conditions. Seedlings were grown with or without cinnamic acid under both iron-sufficient and iron-deficient conditions. Phenotypic parameters including plant height, biomass, chlorophyll concentration and visible chlorosis were collected. We found the application of cinnamic acid significantly reduced iron deficiency-induced chlorosis and supported plant development. RNA from root tissues was analyzed to assess gene expression related to iron homeostasis. The findings indicate that cinnamic acid improves soybean tolerance to iron deficiency, likely by influencing iron acquisition and transport. This research highlights cinnamic acid as a potential strategy for managing iron deficiency in soybean and expands understanding of phenolic acids in nutrient stress adaptation.

Advancing Wound Healing: Exploring Electrospun Fibers and Cell Culture Dynamics

Baylee Mabry *[Mentor: S. Hamilton]*

Ouachita Baptist University - Biology

Wound healing is a multi-billion dollar global industry that impacts millions of people worldwide. Advances in wound healing research have led to biodegradable alternatives to traditional gauze and bandages, which offer limited support for active tissue regeneration. A promising method for enhancing wound healing is electrospinning, which produces nanofibrous constructs with architectures similar to that of the extracellular matrix (ECM). For this study, sodium alginate (SA), a natural polymer, was modified to create a bioactive and degradable material (oxbAlg) that mimics the functionality of collagen in the body. Characterization of the and oxbAlg was performed via infrared and UV-Vis spectroscopy to ensure a successful functionalization and to quantify the degree of oxidation. The oxbAlg was electrospun with poly(vinyl alcohol) (PVA) that had been dissolved in $CaCO_3$ and epichlorohydrin as a cross-linker. These nanofiber mats were analyzed in vitro using HaCaT cells, a spontaneously immortalized human keratinocyte cell line, using a Live/Dead assay, a scratch assay, and an MTS assay conducted to assess cell viability, migration, and proliferation. Future work will be focused on testing the hemostatic capabilities of the mats as it is anticipated that these constructs will lend themselves towards a variety of biomedical applications, particularly wound healing.

Plastic-Eating Super Worms: An Interdisciplinary Study of Waxworm-Mediated Plastic Biodegradation

Mishka H. Jeevan and César Vargas Perez *[Mentor: M. Dolan]*

Arkansas State University - Biology | Chemistry

Plastic pollution is a major environmental challenge, as many widely used plastics persist for decades after disposal. This project integrates biological and chemical approaches to develop a more effective and sustainable strategy for degrading low-density polyethylene (LDPE), a common packaging plastic. Galleria mellonella (waxworm) larvae have emerged as a promising model for their ability to biodegrade LDPE and convert it into compounds with potential downstream applications. Evidence suggests that enzymes present in waxworm saliva play a key role thus we investigated whether dietary modification of waxworms can enhance salivary enzymes involved in LDPE biodegradation. Saliva extracts are applied to LDPE, and changes in polymer bond chemistry are analyzed using Fourier-transform infrared spectroscopy. In collaboration with the Department of Chemistry, an electrochemical pretreatment is being evaluated to modify the LDPE surface and increase its susceptibility to enzymatic degradation under environmentally friendly conditions. Additionally, in partnership with Mechanical Engineering, nanoindentation techniques are used to quantify changes in plastic surface properties following biological and chemical treatments. Combining biological optimization/chemical surface modification, this project aims to enhance plastic biodegradation efficiency and support development of sustainable strategies to mitigate plastic waste.

Analysis of Thrombin Release from Natural Polymer-Based Nanofibers Towards the Development of Bioactive Wound Dressings

Gracie Moore *[Mentor: S. Hamilton]*

Ouachita Baptist University - Biology

The development of biocompatible clotting agents has been a longstanding focus of research in the medical field, as hemorrhaging accounts for 40% of all trauma-related deaths globally. Alginate is a biocompatible and biodegradable polymer that has been used in fibrous wound dressings. Calcium is an essential element in the clotting cascade that can be embedded within a variety of materials to encourage hemostasis. The Hamilton lab synthesizes an oxidized, biomimetic alginate (oxbAlg), which features functional groups similar to collagen, to enhance its functionality within the body. The oxbAlg was electrospun with other polymers and therapeutics to create biomimetic fibers imbedded with thrombin and calcium ions, both of which promote blood clotting. Various crosslinking strategies were explored to enhance the physical properties of the fibers and preliminary X-ray fluorescence analysis quantified the calcium concentration within individual cut fiber mats. The release of thrombin from these fibers was analyzed via ELISA assay at specified time points. It is believed that these fibers will have an increased effectiveness in clotting assays compared to controls, including commercially available materials.

Aging in Arkansas: Advocating for Aging-in-Place Initiatives and Empowering Occupational Therapy Students Through Legislative Action within the State of Arkansas

Sumner Rose Huerkamp *[Mentor: B. Pate]*

University of Central Arkansas - Physical / Occupational Therapy

As the older adult population in the U.S. continues to expand, aging in place (AIP) has become a critical priority for healthcare systems. Occupational therapy (OT) supports AIP through interventions that promote functional independence, environmental accessibility, and participation in meaningful occupations; however, legislative and reimbursement barriers limit access to preventative services and home modifications. Advocacy is a core component of OT practice, yet limited engagement and preparedness within the profession reduce its influence on policy. This project examines advocacy gaps within OT in Arkansas through surveys of occupational therapy students and state legislators, as well as interviews with state and national OT advocacy leaders. Results indicate that while students overwhelmingly recognize the importance of advocacy, many report limited confidence in understanding legislation, identifying advocacy resources, and engaging in real-world advocacy efforts. Legislators demonstrated variable confidence in their understanding of occupational therapy's scope of practice. A doctoral capstone project was developed to strengthen advocacy competence among OT students through education and hands-on legislative engagement. The project will include an advocacy event at the Arkansas State Capitol to educate policymakers on occupational therapy's role in aging in place. Strengthening advocacy knowledge may improve policy alignment and outcomes.

Effects of a Nutrition Education Program

Georgie Crain and Abigail McMahon *[Mentor: D. Brech]*

Ouachita Baptist University - Nutrition and Dietetics

Approximately 14.7 million U.S. children and adolescents have obesity, which is defined as a child having a body mass index (BMI) at or above the 95th percentile for their age and sex. An important factor in the prevention of child-hood obesity is nutrition and physical activity education.
Hypothesis: There will be a statistical difference, showing a decrease from pre-assessment to post-assessment BMI-for-age percentile of the children who received nutrition and physical activity focused education and there will be no statistical difference between pre-assessment and post-assessment BMI-for-age percentile of the children who did not receive nutrition and physical activity focused education.

Methods: Three summer childcare programs participated as research sites for the study. The pre-assessment consisted of 96 children in the treatment group and 21 children in the control group. The post-assessment consisted of 77 children in the treatment group and 22 children in the control group. Nutrition and physical activity lessons were taught to the treatment group for seven weeks.Results: By the end of the seven weeks, nine children moved into a healthier weight category from the treatment group.

Conclusion: No correlation was found between BMI and age in either the control or the treatment group.. These findings support the effectiveness and benefits of a nutrition and physical activity education program for children. There was a statistical difference in both groups.

Applying computer science to analyze handwriting for the purpose of developing a dyslexia screening tool

Walter (Travis) Blamer, Sarah (Hanley) Lane and Quang Dang *[Mentor: A. Pait]*

Arkansas State University - Computer Science | Communication Disorders

Dyslexia is a multifactorial, language-based learning disability affecting an estimated 15–20% of the population, yet it remains inconsistently identified in schools. Despite its substantial academic and psychosocial impact, many children are not diagnosed until late elementary grades. Existing screening practices lack cohesion and often fail to distinguish dyslexia from general reading difficulties, particularly in young learners. Emerging research indicates that early deficits in fine motor coordination and handwriting may provide observable indicators of dyslexia before formal reading instruction begins. However, no current screening tool systematically evaluates handwriting for early identification.

This work introduces an iPadOS application developed to support an ongoing study investigating whether a handwriting-based screening measure focused on letter formation can differentiate children who exhibit characteristics of dyslexia from those who do not. Using the Apple Pencil, the system captures high-resolution, stroke-level handwriting data during structured tasks, supplying input for a machine learning model. By analyzing qualitative differences in grapheme production, this research aims to advance a more reliable and accessible early screening approach for school-aged children. The central question guiding this work is whether machine learning can effectively predict which kindergarten and first-grade students display characteristics of dyslexia and which do not.

A Comprehensive Survey of Agentic AI: Design Principles, Security Risks, and Ethical Considerations

Md Shaba Sayeed *[Mentor: R. Ghosh]*

Arkansas Tech University - Computer Science | Engineering

In the past several years, the world has managed to transition away from simple automation to independent AI systems. Agentic AI is an agent that can work independently, carrying out all essential plans and implementations without any kind of supervision from a human being.This review has tried to demonstrate the transformative impact that Agentic AI brings to contemporary models of intelligence by means of synthesis of perception, reasoning, and goal. We utilized the phrases Agentic AI,autonomous AI,multi agent systems as keywords in Google Scholar, ScienceDirect, arXiv, and other digital libraries.We have used these 38 main papers published between 2023 and present as part of search process.This paper has taken a deep, close approach to Agentic AI systems, thereby discussing their technical foundations, challenges, applications, and societal impacts. In this paper, we discuss the different aspects of Agentic AI, including the technical side, challenges, applications, and impacts. In this study we found Agentic AI systems are capable of a 34.2 % reduction in the time of task execution, a 7.7 % increase in accuracy, and a 13.6 % improvement in resource utilization. In this survey, we investigate the performance and benchmarking of model architectures, security, privacy, and human-in-the-loop integration; and analyze frameworks for efficient human-AI collaboration. This survey draws on ideas from recent publications.

White-Tailed Deer-Car Collision Prevention

Felix Mason Waller *[Mentors: W. Cheng]*

Southern Arkansas University - Computer Science

In Arkansas, white-tailed deer are commonplace. The abundance of deer in Arkansas poses a risk to the drivers and passengers of on-road vehicles in Arkansas, due to vehicle-deer collisions. This study intends to spread awareness on the factors that persuade deer activity in Arkansas, so that drivers allocate more awareness, or avoid driving entirely, when those factors are present. Using data on white-tailed deer in Arkansas– provided by the National Park Service's "White Tailed Deer Monitoring" dataset– comparisons on total deer sighted against vegetation types, years, hours of the day, temperatures, humidity, precipitation, moon illumination, and cloud cover were all graphed for study through R Studio. The results of this study indicate that white-tailed deer in Arkansas prefer to be active in grassland/prairie and crop/farmland environments, temperatures in the range of 59-68 degrees Fahrenheit, a shift in precipitation from light rain to no rain, a shift from fog to light rain, 20-25% humidity, and 95-100% humidity. Moon illumination and cloud cover showed no correlation with total deer sighted. The above deer preferences should be considered when planning to drive in order to avoid a vehicle-deer collision. For simplicity, a program to predict the probability of deer in a set, Arkansas location by comparing vegetation type, temperature, humidity, precipitation, and the time of day to that of the preference of white-tailed deer is in development.

Concentrating Lithium Brine Using Reduced Graphene Oxide Forward Osmosis Membranes

Kolton Claybrook *[Mentor: W. Zhao]*

University of Arkansas—Little Rock - Computer Science

The Smackover Formation brines in southern Arkansas contain a large quantity of lithium, a critical resource for electric vehicle batteries and the global energy transition. To extract the lithium, efficient downstream enrichment technologies are urgently needed. Methods for direct lithium extraction are being explored, followed by further purification and concentration of the lithium salt solution, such as using reverse osmosis, which is energy intensive. Here we use reduced graphene oxide (RGO) membrane-based forward osmosis (FO) as an environment-friendly and near zero-energy input method to concentrate lithium brine. In the FO tests, a saturated NaCl solution serves as a draw solution and either a dilute $LiNO_3$ solution (50.4 mM) or an artificial lithium brine (1 M NaCl + 12 mM $LiNO_3$) as a feed solution, where $LiNO_3$ is selected to mimics the typical LiCl component in lithium brine. Because nitrates have a unique absorption feature at ~300 nm, their concentrations in both the feed and draw solutions can be monitored by a facile UV-VIS absorption spectral method. For the dilute $LiNO_3$ solution, a rejection rate is determined to be 98%, with a water flux of 6.2 L/hm2. For the artificial brine, a rejection rate of 88% and a water flux of 5.0 L/hm2 are observed. With further optimization, this forward osmosis approach could provide a more energy-efficient method for lithium salt enrichment, supporting sustainable lithium extraction from Smackover brines.

Adoption and Performance of Java Try-With -Resources in Open-Source Projects

Sara Momen, Samir Kumar Shah, and Trishna Niraula

[Mentor: D. Kim]

Arkansas State University - Computer Science

Resource management is critical for the reliability and performance of Java applications. Traditional try–finally blocks are verbose and error-prone, often leading to resource leaks and reduced maintainability. Java 7 introduced Try-With-Resources (TWR) to simplify resource handling, but its real-world adoption and performance impact in open-source ecosystems have not been thoroughly studied. This paper addresses two research questions: (1) How has the adoption of Try-With-Resources evolved over time in open-source Java projects? (2) How does the runtime performance of TWR compare with manual try–finally resource management across different workloads?

We conducted a longitudinal static analysis of seven large open-source Java projects, mining their Git histories to track Try-With-Resources usage over time. We also ran controlled micro-benchmarks comparing TWR with manual cleanup across common I/O workloads, including COPY, SCAN, SMALL, MIXED, and ZIPSCAN. Results show that TWR adoption has steadily increased in I/O-intensive projects, while legacy or container-managed systems exhibit lower usage. Performance evaluation reveals that TWR is generally competitive with manual cleanup, though small, high-frequency I/O workloads may incur modest overhead. Try-With-Resources improves readability and safety with little performance cost, so it should be the default; use manual cleanup only for carefully tested performance-critical code.

Optimizing Energy Consumption to Minimize Carbon Emissions: A Machine Learning Approach for Facility Operations

Malaya Wilburd *[Mentor: T. Ensari]*

Arkansas Tech University - Computer Science | Engineering

This project explores the use of machine learning to optimize building energy consumption and minimize carbon emissions while maintaining occupant comfort as well as operational costs. The study utilizes a comprehensive three-year dataset curated from an office building constructed in 2015 in Berkeley, California, integrating weather conditions, HVAC system operating conditions, control signals, occupancy proxies, and system performance. A predictive modeling framework will be developed to forecast hour-ahead energy load and zone temperatures. Gradient Boosting models will be implemented to capture both nonlinear relationships and temporal dynamics in the data. The forecasts will be implemented into a learning-augmented control approach designed to adjust HVAC set points and operational strategies. Preliminary findings are expected to show that short-term forecasting can accurately predict energy demand and thermal conditions, enabling control strategies that reduce kWh usage and CO_2 emissions without compromising occupancy comfort. The results are expected to highlight the potential of data-driven intelligence to enhance facility operations and advance sustainable energy management.

A Hybrid Entity Resolution Pipeline Integrating LLM Intelligence, Semantic Clustering, and Household Movement Analysis

Ammar Ahmed Taha Mohammed

[Mentor: J. R. Talburt]

University of Arkansas—Little Rock - Information Science

Entity resolution (ER) identifies and links records that refer to the same real-world entity across datasets. Accurate ER is critical in healthcare, finance, and government applications, where duplicate or fragmented data can distort analytics and policy decisions. This paper presents a twelve-stage hybrid ER pipeline combining rule-based preprocessing, semantic embeddings, clustering, and large language model (LLM)-assisted refinement to handle noisy and large-scale data. The approach also introduces household movement analysis to capture relationships across multiple addresses. Experiments on thirteen benchmark datasets and six corrupted variants achieved F1 scores above 98% and Adjusted Rand Index (ARI) values exceeding 0.999, with robustness losses below 0.3% under severe noise. Efficiency tests show near-linear scalability and about 80% cost reduction using batch inference and caching. The proposed framework provides a transparent and cost-effective solution for accurate, interpretable, and large-scale entity resolution.

Domestic Kinetic Power Design with Additive Manufacturing

Andrew Allen Grace *[Mentors: S. Sharma]*

Arkansas State University - Engineering

Additive manufacturing in the home has proliferated within the last decade with the advent of devices that make the design and manufacturing of a variety of plastics easily possible for even novices. "3D Printers," as they are commonly known, have a typical maximum printing size that's congruent with the needs of creating smaller-scale, home-use wind and fluid kinetic energy conversion and storage devices. This project began as an attempt to improve the components of a science kit for wind energy, and those goals were reached with minimal complications. With proper manipulation of the parameters for printing, we were able to improve the efficiency of the original kit's components' respective current output typically by over 200%. A local industry partner with our college saw our designs and was interested in having us do similar work for them. Our goal is to try to create an accessible, and user-friendly method of making semi-DIY wind energy generation "kits" that will utilize 3D printing to meet localized needs. Our methods have included use of heated extrusion CNC printing, and UV resin printing, utilizing PLA and TPU as materials. Our designs will also meet dimensional constraints of typical, low-end-priced additive manufacturing devices but also keep the kits simple for users. Our work has demonstrated a variety of home-use compatible designs, that can be affordably printed, and affixed to prescribed components to create effective wind-energy-conversion devices.

AMR Use on Construction Sites

Travis Allbritton *[Mentor: S. E. Taghavi]*

University of Arkansas—Pine Bluff - Engineering | Industrial Technology Management

This research investigates the integration of AI-powered robots in building construction, aiming to improve efficiency, safety, and scalability in large-scale projects. This study currently focuses on three primary objectives:

   1. Evaluate the feasibility of multiprocessor architectures for autonomous robotic control and decision-making.

   2. Develop strategies for sensor fusion to enable real-time environmental awareness and adaptive responses.

   3. Assess cost-effectiveness and safety benefits compared to human labor, particularly in hazardous or high-risk environments.

In addition to addressing these objectives, the paper examines the challenge of semantic interoperability and emphasizes the need for global standards to ensure component reusability and seamless integration. The potential industry impact includes reducing chronic injuries among workers, lowering operational costs, and accelerating project timelines through automation. By establishing interoperability frameworks and advanced control mechanisms, this research positions AI-driven robotics as a transformative force in construction, paving the way for safer, more efficient, and technologically advanced building practices.

Design and Implementation of a Telemetry System for a CanSat with Autogyro-Based Descent Control

Michael Salvatierra, Roberto Martínez, Luis Chojolan, Hasly Perez, Evan Jenkins, Iker García, and Luke Main *[Mentor: T. Gilmour]*

John Brown University - Engineering

This project presents a telemetry system for a CanSat platform incorporating an autogyro-based descent control mechanism. The objective of the system is to enable reliable real-time data acquisition and transmission while ensuring a controlled and stable recovery profile using passive aerodynamic principles. The CanSat integrates sensors to measure flight parameters, including altitude, temperature, pressure, orientation, and GPS position. These data are processed by an embedded microcontroller and transmitted wirelessly to a ground station for live monitoring and post-mission analysis. To enhance mission safety and data integrity, an autogyro mechanism is employed during descent, reducing terminal velocity and improving stability without the need for active propulsion or complex control algorithms. The system was designed with an emphasis on low power consumption, modularity, robustness, meeting competition constraints on size, mass, reliability. Ground testing and subsystem validation were conducted to verify sensor accuracy, communication range, and descent behavior. This project demonstrates the feasibility of combining compact telemetry architecture with passive autogyro recovery system in a CanSat mission. The results contribute to student-led research by showcasing an accessible approach to controlled descent and real-time telemetry in small-scale satellite simulations.

Precipitation of MnS Inclusions in Silicon Steels and their Influence on Grain Growth

Caden Grimmett *[Mentors: D. Fleming]*

Arkansas State University - Engineering

Manganese sulfide (MnS) inclusions are thermodynamically stable precipitates that are known to form in Si steels used in electrical applications. However, the formation of these precipitates is detrimental to the magnetic properties of the steels, leading to increased core loss and lower magnetic permeability, while also influencing the grain growth kinetics. This study focuses on the nucleation and precipitation of MnS inclusions in a model Si steel (Fe-Si-Mn-S), as well as their effect on the grain growth and equilibrium grain size. Using computational thermodynamic modeling, precipitation models for MnS in both ferrite and austenite phases are utilized to characterize the nucleation kinetics in common electrical steel processing conditions. Finally, grain growth models, both with and without Zener pinning from the MnS precipitates, are used to assess the impact of precipitate pinning on average grain size and growth rate. This study provides analysis, behavioral prediction, and preferred processing parameters to mitigate the severity of MnS inclusions, which in turn improves magnetic performance and microstructural stability in electrical steels.

Detecting the undetectable

Hannah Jones *[Mentor: S. Dabetwar]*

University of Arkansas—Little Rock - Engineering

In recent years, composite materials have gained widespread popularity across various applications. Wind turbine blades, namely, have a significant relevance, using composite glass fiber reinforced polymer materials in their application. Due to their outdoor use, the blades are susceptible to impact damage. At times, when the blade is impacted at the surface, larger damage can lie beneath the surface of the material and can propagate through the blade under continuous loading if not detected in time, leading to catastrophic failure of the blade. This type of damage, barely visible impact damage, is difficult to detect visually and often requires nondestructive methods, typically associated with an increase in expense. To counteract costs, infrared thermography can be implemented. However, classifying the images from inspection is time-consuming and requires automation. Thus, automation through deep learning algorithms can be implemented, and the appropriate hyperparameters must be selected for optimal model performance. In this study, the model performance of two transfer learning algorithms (VGG16 and InceptionV3) were compared to a traditional CNN model to determine the number of images needed to attain a sufficient model performance. In determining the data sufficiency of these models, computational time and expense can be reduced by only using the number of images necessary for optimal performance.

Optimal Control of Neuronal Firing Using the FitzHugh-Nagumo Model

Qingqi Jiang *[Mentor: W. Liu]*

University of Central Arkansas - Mathematics

Precise control of neuronal activity is crucial for therapeutic interventions such as deep brain stimulation for Parkinson's disease and epilepsy treatment. This study investigates optimal control strategies for regulating neuronal membrane potential using the FitzHugh-Nagumo (FHN) model, a simplified yet physiologically relevant representation of neuronal excitability. We formulate the control problem as minimizing a cost functional balancing control effort against deviation from a target membrane potential. Using Pontryagin's Maximum Principle, we derive optimal control laws and implement them numerically via the forward-backward sweep algorithm. This algorithm iteratively solves state equations forward in time and costate equations backward until convergence. Results demonstrate smooth convergence over 120 iterations, reducing the cost functional by approximately 95% compared to uncontrolled dynamics. The optimal control successfully drives membrane potential to the target while minimizing energy expenditure. We also explore time-optimal control formulations, deriving bang-bang control structures that minimize time to reach the target state. This work demonstrates the effectiveness of optimal control theory for regulating neuronal dynamics and provides a computational framework applicable to designing neural stimulation protocols in clinical settings.

A Comprehensive Review of ISO Standards Governing Steel Composition, Mechanical Testing, Heat Treatment, and Dimensional Tolerances

Ian Archer *[Mentor: R. Sharma]*

Arkansas State University - Engineering

The International Organization for Standardization (ISO) publishes standards that are used worldwide to make sure steel products are safe, consistent, and reliable. This project reviews several key ISO standards related to steel and explains how they guide material classification, chemical composition, mechanical properties, testing methods, heat treatment, and dimensional tolerances. These standards help engineers choose appropriate materials, compare test results across research centers, and verify that steel composites will perform as expected in real world scenarios.

Distribution and Establishment of Lycoris radiata var. radiata (Amaryllidaceae) in the Arkansas (U.S.A.) Flora

Conner J. McQueen, Lydia I. Serviss, Jonathan R. Kratz, Zoie M. Autrey *[Mentor: B. Serviss]*

Henderson State University - Biology

Naturalized Lycoris radiata var. radiata was not well-studied in Arkansas prior to 2024, and as a result, the species was known outside of cultivation only from Clark, Ouachita, and Drew counties, and equivocal as to how this sterile, triploid taxon establishes wild populations in the state. Field work in southern and western Arkansas during 2024 and 2025, focusing on the occurrence and establishment ecology of L. radiata var. radiata, yielded 16 additional county records of naturalized plants and a putative mechanism facilitating establishment in the flora. While many of the naturalized occurrences of L. radiata var. radiata are tied directly to source pools of cultivated plants, some instances are more remote, indicating that one or more propagule dispersal mechanisms exist. We propose a mechanism of naturalization from asexual production of bulblets and their migration toward the surface of substrate — exposed bulblets at the soil surface then provide opportunity for separation from the parent colony and subsequent dispersal via multiple vectors, primarily water movement, to remote locations for establishment.

Microplastic Abundance and Variation within Non-Web Building Spiders: Dolomedidae

Isaac Teague *[Mentor: J. Ortega]*

University of Arkansas—Fort Smith - Biology

Microplastics are a pollutant that has gained recent attention due to their potentially harmful effects on the environment, wildlife, and human health and well-being. While microplastics were originally discovered and researched in the marine aquatic environment, recent studies suggest microplastics are dispersed throughout terrestrial environments. Through the soil, food sources, and water cycle, organisms such as terrestrial arthropods incorporate these microplastics by ingestion of prey item and hydration sources, gas exchange, and adherence. Our aim was to identify microplastic variation (type) and abundance (quantity) within terrestrial non-web building spiders across Fort Smith, Arkansas. We use chemical techniques and Raman spectroscopy to identify microplastic particle type, size, shape, and overall abundance. This study works to advance scientific understanding of the types of microplastics being ingested and the quantity, implicating the health of urban environment in which they are in. As well as identifying microplastic microhabitat aggregation, these findings also aim to help uncover the biomagnification of this pollutant throughout the life history of these arachnids.

Genomic Analysis of Salmonella Resistance and Virulence in Food Animals

Ni'Yasha Franklin *[Mentor: V. Raj]*

University of Arkansas—Pine Bluff - Biology

This study demonstrates that Salmonella possesses both antimicrobial resistance and virulence genes, showing its ability to adapt genetically and survive in food animals. These traits make it more difficult to control in agriculture and increase the risk of severe illness in humans. Overall, the findings emphasize the importance of monitoring Salmonella in food animals to protect both food safety and public health.

Investigating Microplastic Pollution Patterns in Web-using Arachnids (Araneidae and Tetragnathidae)

Shelby Zink *[Mentor: J. Ortega]*

University of Arkansas—Fort Smith - Biology

Microplastic (MP) pollution poses a global threat to human health, wildlife, and the environment. Research on aquatic MP detection has grown, while reliable methods for sampling airborne MPs remains limited. Recent work indicates that spider webs can serve as effective natural assays for airborne MPs and could potentially be used to monitor MPs in terrestrial areas. Our study aims to validate and expand recent methodology by examining MP patterns in webs across Fort Smith, Arkansas. We use chemical techniques and Raman spectroscopy to identify particle load, type, and size. Our study advances the knowledge of airborne MP distribution and reveal the biological implications of widespread pollution. Beyond identifying zones of contamination, this work provides critical insight into how urbanization impacts the life history of arachnid species. The results aid in the development of accurate airborne monitoring methods and potentially create a framework for future pollution studies.

Optimization of seed potato cv. Russet Burbank using a vertical hydroponics system.

Lucas Warren and Nyla Compeaux *[Mentor: A. Q. Ferrer]*

University of Arkansas—Monticello - Biology

The potato, Solanum tuberosum, is one of the worlds most important crops. To illustrate, it serves as a staple food item in the diets of 50% of the global population. When a crop has a demand this high, usual methods of growth, which come with high rates of disease and low rates of multiplication, do not satisfy the levels of global consumption. One of the most versatile and cost-effective ways to combat the ever-growing need of crops such as S. tuberosum, specifically cv. Russet Burbank, is hydroponics. There are multiple hydroponic systems in agriculture such as Nutrient Film Technique (NFT), Deep Water Culture (DWC), Ebb and Flow (Flood and Drain), etc. However, there are more effective systems that have not been explored as much in the industry such as vertical hydroponic systems. In addition, crops such as potatoes have not been implemented in a system such as this before. Through this project we seek to test the use of certified seed potato in a vertical hydroponic system for the first time in Arkansas.

The Genus Phyllostachys (Poaceae, Bambusoideae) in the Arkansas (U.S.A.) Flora

Jonathan R. Kratz and Dakota Ashley   *[Mentor: B. Serviss]*

Henderson State University - Biology

Previously, the genus Phyllostachys was not well-studied in the Arkansas flora and only P. aurea was known from the state in the naturalized condition. Field work in 2025 by the authors in central and western Arkansas has increased the known distribution of P. aurea and documented the first occurrences of three additional species of Phyllostachys: P. aureosulcata, P. bambusoides, and P. nigra outside of cultivation. Whereas P. bambusoides and P. nigra are infrequent (known from 2 and 1 county, respectively), P. aureosulcata has a more wide-spread distribution in Arkansas, where it is documented from several counties. Phyllostachys aureosulcata and P. aurea are similar morphologically and easily confused without close examination, which may explain why P. aureosulcata remained undetected in the state's flora until now. Keys to identification of Arkansas Phyllostachys species and morphologically similar taxa, diagnostic and habitat photographs, current state distributions, and notes on their ecology and invasiveness are provided.

Bridging Training and Practice: Technology Integration in Geometry Classrooms

Rebecca Bottey *[Mentor: S. A. Sanjari Pirmahaleh]*

University of Central Arkansas - Mathematics

This study investigated the impact of pre-service teachers' training on the integration of GeoGebra in geometry classrooms. The study used a quasi-experimental pretest-posttest design. Two pre-service classes were used in this study; one group served as the control group, and the other as the experimental group. The control group received the traditional lecture method instruction, and the experimental group participated in a GeoGebra-supported training where the instruction centered on Rotation and Reflection. Data was collected using a pre-test and post-test assessment and a pre- and post-test survey. The Survey of Preservice Teachers' Knowledge of Teaching and Technology (TPACK Survey; Schmidt et al., 2009) was modified and used to assess pre-service teachers' confidence, instructional readiness and perception of technology integration in the geometry classroom. The study used a Quantitative analysis to measure the outcome of the data collected.

The analysis showed that participants in both groups demonstrated greater gains in conceptual understanding of geometric transformations, even though the technology class demonstrated a higher level of understanding as compared to the control group. However, Survey results and post-test from the experimental group further indicated an increased confidence and willingness to integrate technology into geometry instruction among those who received GeoGebra training.

Neuromorphic Seizure Detection: EEG Analysis with Spiking Neural Networks

Shruti Bhandari and Md Shaba Sayeed *[Mentor: T. Ensari]*

Arkansas Tech University - Computer Science

Epilepsy is a significant chronic neurological illness that can be identified by examining the brain signals generated by neurons. Undergoing an epileptic seizure might result in significant repercussions for the individual. Automated seizure detection in electroencephalogram (EEG) recordings are crucial because of the erratic and unpredictable characteristics of seizures. Traditional Deep Learning models such as CNNs and LSTMs have a good amount of accuracy but they have some limitations due to computational expense factors and unsuitable for low power wearables devices. This Research presents lightweight, energy efficient seizure detection approach using Spiking Neural Networks (SNNs) by the event driven firing behavior of biological neurons. This study demonstrates a method that reduces noise in EEG signals and enables faster recognition of temporal patterns. The proposed Spiking Neural Network (SNN) model utilizes Leaky Integrate and Fire neurons to classify seizure and non-seizure states in real time, emphasizing early warning capabilities. In this study, we employ the CHB-MIT scalp EEG database, which includes long-term multi-channel EEG recordings from pediatric epilepsy patients. Preliminary analysis indicates that SNNs can achieve competitive accuracy while significantly enhancing responsiveness and reducing energy consumption, positioning them as strong candidates for neuromorphic, wearable seizure monitoring systems.

Small Language Models for Edge AI: Enabling Private, Efficient On-Device Intelligence

Kaan Boke *[Mentor: T. Ensari]*

Arkansas Tech University - Computer Science

Large language models (LLMs) now power many AI systems, but their massive size and reliance on cloud servers make them difficult to deploy on personal devices and raise privacy and latency concerns. Small Language Models (SLMs) offer a complementary path: models intentionally sized to fit within the memory and compute limits of phones, laptops, and embedded hardware while still solving specialized language tasks. Recent work shows that compressed and distilled models can retain most of the accuracy of their larger counterparts while running much faster and using significantly less memory, making them strong candidates for edge AI.

This poster introduces SLMs to a broad STEM audience and explains how they enable on-device AI. We outline the key techniques used to build effective SLMs knowledge distillation, pruning, quantization, and efficient fine-tuning and how these methods shrink models without destroying their capabilities.

Using reported benchmarks from recent literature, we compare representative SLMs and LLMs in terms of model size, latency, and task performance, and illustrate deployment scenarios such as offline assistants, privacy-preserving text analysis, and educational tools that work with limited connectivity. We also briefly discuss hybrid "cloud + edge" designs where an on-device SLM handles local or sensitive inputs, while a larger remote model is consulted only for the most complex queries.

Neuromorphic Approaches to Data Compression with Spiking Models

Malaya Wilburd, Shruti Bhandari, Md Shaba Sayeed, Harsha V Gudala   *[Mentor: T. Ensari]*

Arkansas Tech University - Computer Science

Spiking Neural Networks (SNNs) is effective for data compression by offering a biologically inspired and energy-efficient framework by encoding information as sparse, event-driven spike trains rather than continuous activations. This project explores how SNNs can learn compact representations of data through temporal coding, sparse firing, and mechanisms such as spike-timing-dependent plasticity. By comparing traditional neural network-based compression approaches, such as autoencoders or ANNs, with spike-based encoding models, this study investigates how SNNS reduce redundancy while preserving the significant structure in signals. The research focuses on implementing and analysing SNNs and event-driven compression strategies to evaluate data reconstruction quality, compression ratios, and energy/computational efficiency. Overall, this research aims to demonstrate how spike-based computation can serve as a proficient approach for data compression, especially in real-time or low-power environments such as sensor networks or neuromorphic hardware.

Exploring the Kinetics of Human Serum Albumin with 4Z,15Z-bilirubin IXα and Its Implications for Jaundice Detection

Samuel Paez *[Mentor: S. Newton]*

John Brown University - Biology | Chemistry

With the rise of new diagnostic technologies such as diffuse reflectance spectroscopy for detecting hyperbilirubinemia in patients via physiological jaundice, much research has been dedicated to the physical and biological properties of bilirubin. However, many of these tools such as bilirubinometers come with perplexing limitations which reflect how much is still unknown about how this unique molecule is processed in the human body. For this reason, the present research aims to shorten this gap by investigating the chemical equilibrium between human serum albumin and bilirubin in the blood. Since albumin is the major transporter of unconjugated bilirubin in human blood, this equilibrium likely dictates how quickly bilirubin is deposited in vulnerable neural tissue where the biomolecule exerts its neurotoxicity. This research is composed of two sections: an in-depth computational study of three-dimensional structures and binding affinities, as well as an in-lab portion where actual samples are subjected to diverse analytical techniques. The objective is to determine the equilibrium constant, which can then be used to convert well-known, in-serum bilirubin concentrations into the lesser-known tissue concentrations. This research may not only inform future diagnostics but also shed light on the biochemistry of bilirubin metabolism and the major factors that influence this molecule's transportation.

Virtual Reality for Labour Induction

Sayed M Samiul Amin *[Mentor: S. Amin]*

Southern Arkansas University - Biology

Labour induction is commonly used to initiate childbirth when medically necessary, but traditional methods can be associated with anxiety, pain, and prolonged labour. Emerging technologies like virtual reality (VR) offer immersive experiences that may influence maternal relaxation and pain perception.

This review explored the potential role of VR in labour induction, focusing on clinical effectiveness, patient experience, and safety.

A comprehensive search of peer-reviewed articles from databases including PubMed, Scopus, and Google Scholar was conducted. Studies included examined VR interventions during labour, pain management, and relaxation techniques. Data were synthesized narratively to assess trends, outcomes, and gaps in current knowledge.

Results: Evidence suggests VR can reduce perceived pain, anxiety, and stress during labour. Some studies report shorter labour duration and improved maternal satisfaction, although sample sizes are small and protocols vary. VR was generally well-tolerated, with minimal adverse effects. Research indicates that immersive visual and auditory experiences may positively modulate psychological and physiological responses during labour.

VR shows promise as a non-pharmacological adjunct for labour induction, enhancing maternal comfort and experience. However, further large-scale, randomized trials are required to establish standardized protocols, effectiveness, and safety in diverse obstetric populations.

Impact of a BioBlitz on an Individual's Perception of Community and Nature

Willow McFerran *[Mentor: C. Pierret]*

University of Arkansas—Fort Smith - Biology

Studies have shown that technology has pushed people into more online spaces instead of third spaces, places where people gather outside of their home/work. These third spaces, like parks, are a crucial part of connecting people to their community as well as their environment and have been shown to increase mental wellbeing through doing so. We propose embedding a research project to measure the effect of using green spaces to bring people together in a community lead event called a Bio-Blitz. Our research aims to answer the question, "Will an activity that draws a community together with a focus on nature change their connectedness to that nature and to each other?" We will conduct this research through anonymous, optional surveys, such as the Connectedness to Nature Scale and the Brief Sense of community Scale. By involving schools, organizations, and the entirety of the River Valley area, we will collect a diverse amount of data pertaining to these questions.

High-Power Rocket Mission, Sampling Electrical Conductivity of Soil

India Dennis, Jared Bolanos, Christopher Aidan Castleberry, and Jean-Yves Krishnasing *[Mentor: S. Clardy]*

Henderson State University - Engineering

Following the guidelines of NASA's Student Launch Initiative, the team designs, builds, and flies a reusable high-power rocket that delivers a functional payload supporting autonomous surface science. This project addresses the problem of collecting and analyzing soil data after a high-altitude rocket flight, simulating planetary surface operations relevant to future exploration missions. The team is developing a 3-meter, reusable rocket designed to reach an apogee of 4,000-6,000 ft AGL while maintaining stable ascent, controlled descent, and safe recovery in accordance with Student Launch requirements. The vehicle consists of three separate sections and employs a dual-deployment recovery system, with a drogue parachute at apogee and a main parachute at low altitude, to limit landing energy and ensure reusability.

After landing, the rocket attempts a near-vertical orientation to simplify surface operations and enables an autonomous payload. The payload integrates a custom internal drill sampler that collects a minimum of 50 mL of soil and performs an internal electrical conductivity test within 15 minutes of landing. Quantitative mission targets include a 4,000–6,000 ft flight profile, autonomous soil acquisition, and successful electroconductivity measurement. This work demonstrates the feasibility of coupling high-power rocketry with autonomous surface science, providing a scalable framework for future student-led planetary sampling systems.

Viral Voices: TikTok as a Hub for Sexual Violence Awareness and Healing

Haley Person *[Mentor: S. Bhochhibhoya]*

University of Arkansas—Fayetteville - Medical Sciences | Public Health

Since the popularization of the #MeToo movement, social media sites are increasingly used for disclosing, sharing, and responding to incidences of sexual violence (SV). Tik-Tok is a popular social media app for creating and discovering short-form videos, with a focus on trends, challenges, and viral content. The purpose of this study was to analyze TikTok content to explore the nature of SV awareness and coping strategies shared by TikTok users.

A content analysis was conducted using the Apify TikTok scraper to collect videos related to SV. Information was extracted through quantitative descriptive analysis from 100 videos that used #sexualharrassmentawareness and #sexualassaultawareness. Using a grounded theory approach, two coders analyzed the videos to explore themes related to awareness techniques and coping strategies posted by small businesses, news outlets, health and law professionals, and individual creators.

Improved Electrode for Lithium-Sulphur Battery

Mohammed Naif and Adeniyi Oyebade   *[Mentor: N. Siraj]*

University of Arkansas—Little Rock - Chemistry

Lithium-sulfur (Li-S) batteries have gained significant attention due to high theoretical capacity (1675 mAh/g) and natural abundance of sulfur. In this study, we synthesized lignosulfonate-based phosphorus-nitrogen-doped carbon (PNDC) materials using a microwave-assisted method to serve as a sulfur host for Li-S battery electrodes. The synthesized materials were characterized using scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS) to evaluate pore size distribution and sulfur infiltration. Electrochemical measurements, including cyclic voltammetry, electrochemical impedance spectroscopy, and charge-discharge cycling, were conducted to assess the material's performance. Results demonstrate promising cycling stability and fast charge-discharge capability, indicating the potential of PNDC materials in enhancing sulfur utilization and mitigating polysulfide dissolution. Further optimization, including binder selection, electrolyte concentration studies, and advanced characterization techniques, will aid in improving overall battery performance. This research contributes to the advancement of Li-S battery technology, offering a pathway towards efficient and sustainable energy storage systems critical to meeting the increasing energy demands of modern society.

The effect of simulated microgravity and the female sex on tibia bone properties

Jalal Masoud and Emily Morrison *[Mentor: B. Hill]*

University of Central Arkansas - Biology

Hindlimb suspension (HLS) has been used as a model to simulate spaceflight conditions. We desired to investigate challenges that persist with females in space because the presence of gonadal estrogen help maintain bone integrity. We hypothesize that the loss of gonadal estrogen and HLS will change the bone anatomy and decrease its strength. A tail-ring, hindlimb unloading model was used for 4 wks on 16 wk female mice (n=4 for each group). There were four groups of mice: (1) SHAM non-HLU, (2) SHAM HLU, (3) OVX non-HLU, and (4) OVX HLU. Food, water, and body mass was monitored. At sacrifice, the tibia was isolated, the uterine mass was decreased in OVX mice, and plasma corticosterone levels were elevated in HLU mice. Bone elasticity (Young's modulus) was evaluated using 3-point bending. Cross-sectional structure and elemental composition (calcium and phosphorus) is being evaluated using scanning electron microscopy and energy-dispersive X-ray spectroscopy. It appears that HLU did not have a significant effect on tibia elasticity; however, OVX does appear to induce a decrease in cortical and cavity area in HLU mice. We are still evaluating the biophysical properties of the tibia from the non-HLU mice. Overall, this preliminary study will provide an understanding on how to mitigate bone loss in spaceflight.

Dual Targeting of Cdc42 and Rac1 Reveals Novel Small-Molecule Inhibitors of Metastasis in Triple-Negative Breast Cancer

Ashley M. Wallace, Alexandria C. Lewis, and Emily Esquivel

 [Mentor: D. Muhoza]

University of Arkansas—Monticello - Biology | Chemistry

Hyperactivation of the Rho GTPases Cdc42 and Rac1 contributes to invasive and metastatic behavior in triple-negative breast cancer (TNBC). This study applied structure-based virtual screening and biophysical assays to discover small-molecule dual inhibitors of Cdc42 and Rac1. Drug-like compounds from public and commercial libraries were selected using physicochemical, in silico ADMET, and synthetic-accessibility criteria and docked to Switch I/II surface pockets of both GTPases. Molecular dynamics simulations with MM/GBSA analysis were used to retain ligands that maintained stable binding and favorable predicted free energies. A chemically diverse subset with suitable solubility, metabolic stability, and low toxicity risk was purchased or synthesized. Recombinant Cdc42 and Rac1 were expressed and purified, and compounds were examined in plate-based fluorescence assays that report on GTPase activity and CRIB-domain effector binding. Thermal-shift experiments and fluorescence-based binding measurements confirmed direct target engagement. Several compounds showed low-micromolar apparent affinity for both Cdc42 and Rac1, reduced effector interactions, and acceptable drug-like properties. These data support dual inhibition of Cdc42 and Rac1 as a strategy to interfere with pro-metastatic signaling in TNBC and provide small-molecule candidates suitable for further optimization and testing in cellular models.

Aggregation or Segregation- Exploring the Interactions Between Co-Occurring Species of Dictyostelids from Arkansas

Camelia Vela and Rawan Yasin *[Mentor: S. Baviskar]*

University of Arkansas—Fort Smith - Biology

Dictyostelium amoebae are ubiquitous in forest soil and leaf litter. As bacterial predators, they play an important role in soil microbiome and plant health. Therefore, there is a growing interest in studying the wild isolates of Dictyostelids. When food is available, Dictyostelids lead solitary life. When starved, approximately hundred thousand amoebae aggregate to form a multicellular fruiting body with a base and stalk made of dead cells and sorus containing live spores at the top. Because a subset of starving amoebae self-sacrifice to become stalk to keep remaining live cells aloft, it is considered as an example of altruism. In natural populations, aggregations can form between starving amoebae of different species to form a chimeric fruiting body, which leads to conflict between these species over which cells die to become stalk and which remain alive to become spores. In fall 2024, two different species of Dictyostelids, R3 and R4, were clonally isolated from the same soil sample collected from western Arkansas. Morphological studies and DNA sequencing have established that R3 and R4 belong to different groups of the order Dictyosteliida. Since both R3 and R4 were found from the same one gram of soil sample, it is important to test the hypothesis that R3 and R4 co-aggregate to form chimeric fruiting bodies when cells from both species are mixed in equal proportions. The effects of this interaction on spore production and fruiting body size and production were examined.

Quantitative Characterization of Cellulose Dissolution in Ionic Liquids and Subsequent Biomimetic Applications

Pierre Simonian *[Mentor: J. Alston]*

University of Arkansas—Fayetteville - Biology | Engineering

Cellulose is a biopolymer with high applicability due to its strength, biocompatibility, and biodegradability. However, the intermolecular hydrogen bonds that bind cellulose structure leave it insoluble to common solvents. Ionic liquids such as 1-allyl-3-methylimidazolium chloride (AMImCl) can disrupt these hydrogen bonds to form cellulose in ionic liquid dissolutions. We can regenerate these dissolutions to act as a biopolymer-based biomimetic material. To do this reliably we need well characterized dissolutions. This study characterizes cellulose in ionic liquid dissolutions using AMImCl and microcrystal cellulose (MCC). MCCs are added incrementally to AMImCl solutions to allow for even dissolution. Throughout mixing periods of each addition, a polarizing light microscope (PLM) records samples to determine the amount in which MCCs have dissolved. Once a three, five, and seven weight percentage value (wt%) MCC dissolution is reached, samples undergo a HR20 Rheometer experimental setup to measure resulting solution viscosities. We found there to be a positive correlation between increasing viscosity and MCC wt%, supporting our hypothesis that PLM and calibrated viscosity measurements can be used to evaluate dissolution quality. Using this knowledge leads to an increase in regenerated cellulose strength and accurate property prediction. Subsequent dissolutions of cellulose in AMImCl are utilized to develop potential replacements of cardiovascular technologies such as stints.

Cellulose-phosphate as a Low-Cost Sorbent for Lithium Extraction from Arkansas Brines

Gabrielle Stokes *[Mentor: P. Desrochers]*

University of Central Arkansas - Chemistry

Commercial development of Arkansas's Smackover brines for domestic lithium production requires extraction materials that are affordable, regenerable, and selective in complex ionic environments. We are developing phosphate-functionalized cellulose (P-Cell) as a low-cost sorbent capable of binding lithium ions for lithium extraction and as potential solid supports for printable LFP batteries. An aqueous sodium pyrophosphate method adapted from Huang et al. (J. Food Sci. Tech. 2013) was applied to cellulose powder, filter paper, and starch substrates. Cellulose phosphorylation of these solids was confirmed by ^{31}P NMR and EDX elemental mapping. Preliminary lithium-ion uptake assays were verified by 7Li NMR integral comparisons against a LiCl capillary standard. Recyclability and cation selectivity of P-Cell are currently being tested, including multi-cation environments common in Arkansas Smackover brines. If the cellulose substrate were sourced from abundant renewable Arkansas biomass (like rice straw or sawdust from timber), this project would represent an Arkansas homegrown solution for the development of the state's resources with a significant global impact.

Recapitulating Cardiometabolic Pathology: Nutritional Stress and Fibroblast Dynamics in 3-Dimensional Cardiac Models

Fatima Nazif *[Mentor: R. Bagchi]*

University of Arkansas—Fayetteville - Biology | Medical Sciences

Cardiometabolic diseases are leading causes of morbidity and mortality. The behavior of human cardiac fibroblasts (HCFs) is influenced by substrate stiffness, cell-cell communication, and interactions with the surrounding extracellular matrix —all which are disrupted in disease states. Traditional two-dimensional (2D) culture systems fail to recapitulate these interactions, limiting their physiological relevance. Three-dimensional (3D) bio-printed culture systems preserve cellular architecture and enable better modeling of normal and pathological conditions. We utilized an in vitro high-fat diet model to investigate how fatty acid overload influences signaling pathways in 2D and 3D HCF cultures. We performed mitogen-activated protein kinase (MAPK) protein arrays to assess changes in signaling cascades known to mediate stress, inflammation, and remodeling through the phosphorylation of proteins. Results show that 3D matrix embedded HCFs exhibit reduced MAPK activation under basal conditions, aligning better with in vivo cardiac tissue profiles. The introduction of fatty acid-induced stress revealed differential pathway activation in 2D vs 3D cultures, highlighting the capacity of 3D models to precisely capture cardiac response to nutritional stress. These findings highlight the importance of using 3D culture systems for mechanistic studies of cardiometabolic diseases and may unveil future strategies for assessing the efficacy of anti-obesogenic and other related therapies.

Anthropogenic Materials in American Robin (Turdus migratorius) Nests: Effects on Parasite Load and Urban Nesting Ecology

Emily Kelley *[Mentor: A. Skypala]*

University of Arkansas—Fort Smith - Biology

Urbanization has increased the presence of human-made materials in bird nesting environments, potentially affecting reproductive success and parasite dynamics. The American Robin (Turdus migratorius), a common species that readily adapts to human-altered landscapes, frequently incorporates anthropogenic materials such as plastics, string, and paper into its nests. This study investigates how the use of these materials varies between residential and public nesting sites in Fort Smith, Arkansas, and how material composition relates to ectoparasite presence. In the laboratory, nests were separated into structural layers, and all anthropogenic materials will be identified, measured, and catalogued. Sections of each nest were examined under a dissection microscope to quantify parasite abundance. This project improves understanding of how urban environments influence avian nesting ecology, highlight potential consequences of debris use for bird health, and establish a foundation for future studies on environmental plastic exposure in wildlife.

An analysis of the differential effects of plastic nanoparticle exposure on SH-SY5Y cells

Abigail Young, Justin Gravett, and Charles Patton *[Mentor: J. Hyde]*

Southern Arkansas University - Biology

Nanoplastics are plastic particles less than 1 micrometer in diameter and can have a variety of effects depending on body tissue. Previous studies have shown that these particles readily accumulate in the brain. However, the effects of these plastics on neuron health and activity are largely unknown. This study focuses on investigating the effects of different plastics on the viability and activity of brain SH-SY5Y cells. Plastic containers and raw plastic was ground and filtered to isolate <450 nm particles. Cultured differentiated SH-SY5Y cells where then exposed to multiple plastic types for 24 hours. Cell viability and stress was measured with a presto blue assay and lactate dehydrogenase assay. Finally, exposed cells were sent to the IDEA proteomics facility at UAMS where DIA analysis was used to identify protein expression changes. Significant variations in presto blue and LDH levels were noted across plastic types indicating cell death. Cells also demonstrated major morphology changes after exposure to nanoparticles. Finally, proteomics analysis revealed major changes to mitochondrial and translation related proteins with wide variation depending on plastic type. Ultimately, our findings show significant variation in the effects of different types of plastic. Understanding how nanoplastics interact with neural cells is crucial for determining their broader health implications for human brain health.

Effects of Rapamycin on Age-Related Neuro-degeneration in C. elegans

Christian Bailey and Alejandro Sanchez *[Mentor: M. Farris]*

University of Central Arkansas - Biology

The medical advances of the last century have significantly increased the lifespan of humans, but this increase has not come without challenges. One such challenge is the increased rates of neurodegenerative diseases like Alzheimer Disease (AD) that are more prevalent in older populations. AD is characterized by the aggregation of miscut proteins, in particular amyloid beta and tau, in the neuron, leading to neuronal death. Autophagy is one of the mechanisms in which miscut proteins are degraded; increased autophagy could be an effective AD intervention.

Rapamycin is an FDA-approved drug used to prevent transplant rejection and has been observed to have many other effects, including increasing rates of autophagy and lifespan extension in model organisms. We are studying the effects of rapamycin on lifespan and neurodegeneration symptoms in the model organism Caenorhabditis elegans. C. elegans normally live 2-3 weeks, making them an ideal organism in which to study late-life phenomena like neurodegeneration. We utilize three strains of C. elegans: wild type (N2), induced expression of amyloid beta tagged with yellow fluorescent protein (YFP) (gnals-2), and the YFP control for gnals-2 (gnals1). We expose them to rapamycin or a control and expose the worms to heat stress on day 1, 7, or 13 of treatment, to examine effects in early-, mid-, or late-life, respectively. The rapamycin is expected to have a positive impact on lifespan in the gnals-1, gnals-2, and wild-type strains.

An analysis of 3D printer resin neurotoxicity in cultured SHSY5Y cells

Justin Gravett *[Mentor: J. Hyde]*

Southern Arkansas University - Biology

The recent development of cheap and effective 3D printers has led to a massive increase in the number of printers in homes and exposure to printer resin. This research project focuses on stereolithography printing which uses ultraviolet light to harden liquid resin. Completed prints then undergo post-processing with an isopropanol bath and UV curing to clean and finish the print. These printers can easily expose users to plastic resins and fumes while printing. The goal of this project is to test the cytotoxicity of finished prints on SHY5Y cells. These cells are an immortalized neuroblastoma cell line that is frequently used in neurotoxicology studies. We tested a variety of resins including standard, water washable, transparent, flexible, eco, and bio safe resins. Small pucks of each resin were placed in SHY5Y cell cultures and incubated for 24 hours before testing cell viability. Lactate dehydrogenase testing assayed cell death and presto blue testing assayed cell metabolic activity. Both assays supported the results that water washable and flexible resins were among the most cytotoxic while transparent, bio, and cell safe resins had the least toxicity. Our results emphasized the variety of 3D printer resins and the needed caution in their use.

Investigating the Molecular Mechanisms via which the Plant Growth-Promoting Bacterium, Azospirillum brasilense, Improves Growth in Salt-Stressed Rice

Karis Turner *[Mentor: A. Mukherjee]*

University of Central Arkansas - Biology

Food crops, such as rice and maize, display severe yield losses under salt stress. Furthermore, problems associated with salt stress are expected to worsen due to changing environmental conditions. Therefore, it is necessary to implement sustainable agricultural strategies, such as exploiting beneficial plant-microbe associations. Plants develop beneficial associations with plant growth-promoting bacteria (PGPB), which improve plant growth via multiple mechanisms, including protection against environmental stresses. While the PGPB, Azospirillum brasilense, mitigates salt stress tolerance in crops, little is known about the underlying molecular mechanisms. Previously, we reported A. brasilense inoculation improved rice growth under high salt stress, seven days post-inoculation (dpi). Using RNA sequencing, we identified transcriptomic changes in rice during A. brasilense-mediated salt stress tolerance at two stages: one (early) and seven (late) dpi. We identified differentially expressed genes associated with abscisic acid signaling, antioxidant defense, ion transport, calcium signaling, plant defense, and nutrient transport. Our findings revealed a dynamic, phased response in which A. brasilense promotes early stress buffering and ionic control, followed by later enhancement of nutrient acquisition pathways. Understanding these molecular events will support the development of bioinoculant-based strategies to enhance stress resilience and improve crop yields.

Effect of Land Cover on Arkansas Eastern Wild Turkey Calling Phenology

Trevor Duke *[Mentor: C. Roberts]*

University of Arkansas—Fayetteville - Biology

Arkansas contains a wide range of habitat types— from Delta row-crop systems to the loblolly pines of the Gulf Coastal Plain and the dense hardwood forests of the Ouachita and Ozark Mountains— resulting in variable conditions for Eastern Wild Turkey populations. Because the species is both ecologically important and a prized game bird species, the Arkansas Game and Fish Commission (AGFC) must manage populations while balancing conservation and hunter satisfaction metrics.

Wild Turkey vocalization is important for both reproductive and hunter success, so in Spring 2024, the AGFC deployed acoustic recording units (ARUs) across 95 sites in 12 regions to monitor Wild Turkey vocalization phenology. The ARU data is being processed using BirdNet to quantify the occurrence and timing of turkey vocalizations at each site. To evaluate the influence of habitat characteristics on detection probability, the data will be modeled in relation to land-cover metrics from the Rangeland Analysis Platform and to daily precipitation, wind speed, and minimum and maximum temperature data from gridMET. Results of this study will improve understanding of spatial variation and weather in ARU detections of turkeys to assist biologists and support more informed decisions regarding hunting regulations and public land management across Arkansas.

Zinc oxide nanoparticles effectively treat MDA-MB-231 triple-negative breast cancer cells

Jenna Holmes *[Mentor: A. Showalter]*

Southern Arkansas University - Biology

Approximately 300,000 women in the US are diagnosed with breast cancer yearly, with roughly 42,000 dying of the disease. Many deaths are attributed to triple-negative breast cancer (TNBC) due to its lack of treatable markers such as estrogen, progesterone, and HER2 receptors as well as aggressive, metastatic growth. Many common treatments such as radiation and hormone therapies only effectively treat breast cancer with these markers. They also work best on early stage breast cancer that hasn't metastasized. Our lab aims to identify an effective treatment for TNBC without adverse effects on healthy cells. Nanoparticles remain a popular topic for cancer treatments due to their size, versatility, and potential modifications. Previous studies show metal nanoparticles such as magnesium oxide trigger reactive oxygen species leading to apoptosis. We used zinc oxide (ZnO) nanoparticles to treat triple-negative breast cancer with promising results. Our data shows an effective dose to treat MDA-MB-231 TNBC cells using ZnO nanoparticles as low as 50 μg/mL. The ratio of live to dead cells measured by Live/Dead assay was significantly lower than the untreated cells. Using these promising doses, we will next treat healthy breast cells, MCF10A, to identify a working range for ZnO nanoparticles.

The Impact of Dietary Iron Exposure on Ferritin and Total Iron Stores in Mouse Liver and Skeletal Muscle Tissue

Charlee Scruggs *[Mentor: J. Fiddler]*

University of Arkansas—Fayetteville - Biology | Food Science

About 70% of anemia cases in women and children are caused by iron depletion (ID) worldwide; especially among women of reproductive age. The cutoff to define ID has been challenged, as individuals with serum ferritin values above the cutoff have symptoms of ID. Limited data exists on the consequences of marginal iron depletion. Previous work in the Fiddler lab determined mouse C2C12 myoblast cells exposed to various concentrations of iron chelator deferoxamine (DFO) to induce marginal to severe ID exhibited reductions in mitochondrial function, mass, and membrane potential before the iron status biomarker changed. Muscle cells were used because they contain many iron-dependent proteins including myoglobin, which relies heavily on mitochondria for energy. Muscles require a large amount of energy from the mitochondria to operate. Therefore, studying skeletal muscle cells allow for studying how marginal ID alters the function of the various iron-containing cellular complexes and the function of mitochondria. In this project, cell culture and ICP-MS optimization were performed to quantify iron in mouse muscle, liver, and whole cells to further determine when changes to cell health from ID begin. Mice were fed iron-limited diets of 50mg, 35mg, 20mg, 15mg, and <5mg of iron. As expected, lower dietary iron diets led to reduced iron in the mice tissues. The results provide key data to support designing a clinical trial to evaluate the consequences of marginal ID in at-risk groups.

Feature Ranking of Clinical Risk Factors for Heart-Failure Survival Using Python

Taureen Sprinkle *[Mentor: V. Raj]*

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Accurate identification of clinically meaningful predictors is central to translational data science and reproducible biomedical research. Chicco and Jurman (2020) demonstrated that survival in heart-failure patients can be predicted with high accuracy using only two variables—serum creatinine and ejection fraction—identified through biostatistical feature-ranking methods in R. This work aims to replicate and extend the feature-ranking methodology of Chicco and Jurman using Python-based statistical and machine-learning libraries instead of R. Using the publicly available heart-failure clinical dataset, we implemented a Python workflow incorporating: Correlation analysis (Pearson) to quantify linear associations between clinical variables and survival. Univariate statistical testing (t-tests, chi-square tests) to assess group differences between survivors and non-survivors. Model-based feature importance using logistic regression, random forests, and support vector machines from scikit-learn. Across statistical and machine-learning approaches, serum creatinine and ejection fraction consistently emerged as the strongest predictors of mortality, aligning with the findings of the original publication. The Python workflow successfully reproduced the feature-ranking hierarchy while offering fully documented computational steps. This project demonstrates that Python provides a reproducible platform for learning biostatistical feature-ranking methods in clinical datasets.

Emerging Ionic Nanomedicines: Synthesis, Characterization to In Vitro and In Vivo Performance

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Ionic liquids (molten salts with melting points below 100 oC) have been explored extensively in the last two decades due to their outstanding properties and wide scope of applications. Recently frozen ionic materials (solid at room temperature) are getting tremendous attention due to their ability to form stable nanoparticles. Ionic nanomaterials have been explored recently for multiple applications due to their tunable characteristics. One can easily achieve the desired characteristics by varying counterions and by tailoring the morphology of ionic nanomaterials. Herein, the synthesis and characterization of frozen ionic materials and their nanomaterials are presented for biomedical applications. By tuning the cation and anion, ionic materials with dual toxicity mechanism are synthesized. These ionic materials are converted into nanoparticles of tunable shape, size, and surface characteristics. Detailed photophysical characterization using absorption and fluorescence spectroscopy revealed their improved therapeutic potential. The cellular uptake, cytotoxicity and endocytosis mechanism of combination nanomedicines derived by ion pairing will be discussed. Examination of in vitro and in vivo results revealed that ionic nanomedicine exhibited better performance as compared to their respective parent compounds.

A Probabilistic Approach to Multiscale Simulation: Evaluating Machine-Learned Backmapping Models of Diphenylalanine

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Diphenylalanine (FF) has demonstrated the tendency to form several electrically conductive nanostructures with exciting potential applications in biotechnology and nano-electronics. However, a more rigorous understanding of the self-assembly process is needed for large-scale implementation. Molecular dynamics (MD) simulations allow for the evaluation of fine-grained atomistic interactions crucial for FF self-assembly, but are too computationally expensive to span the necessary timescale to observe the self-assembly process in action. Coarse-grained (CG) models significantly increase computational efficiency, but at the cost of vital atomistic detail. For applications such as FF self-assembly, it is therefore necessary to develop methods of translating between simulation resolutions to probe the essential characteristics while maintaining computational efficiency. In this work, we incorporate machine-learning methods to precisely translate between simulation resolutions for more efficient and informative MD simulations, using FF as a test case. Sampling and analysis of our models demonstrate highly promising results. Evaluation of the RMSD values and potential energies of backmapped structures reveals that the model predicts physically viable, low-energy conformations in the majority of cases. The specialized training procedure additionally allows for a transition to more complex systems, such as long-chain polymers and proteins, with relative ease.

Social Media Use, FoMO, and Impulsive Spending in College Students

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FoMO, or fear of missing out, was first introduced in the early 21st century to describe shifts in consumer behavior (Herman, 2000) but has since been widely examined in the context of social media use. Prior research has separately linked FoMO to both increased social media engagement (Wolniewicz et al., 2018) and impulsive spending (Chen et al., 2022). However, the role of FoMO as a mediator in the relationship between social media use and impulsive spending remains unclear. Given that college students are particularly susceptible to the psychological drivers of impulsive spending (Yaputri et al., 2022), understanding this connection is crucial. Guided by Festinger's (1954) Social Comparison Theory and Ryan and Deci's (2000) Self-Determination Theory, this study aims to clarify how FoMO influences social media use among college students and, in turn, contributes to impulsive spending behaviors. FoMO is measured using the FoMO Scale (Mazlum & Atalay, 2022); social media use is measured using the Social Media Use Scale (Tuck & Thompson, 2023); and spending behaviors is measured using the Spending as Social and Affective Coping Scale (Rice et al., 2020). This research can offer valuable insights into financial decision-making at a time when digital spending is more accessible than ever.

Advanced Material Platforms for Stretchable Bioelectronics and Flexible Circuitry

Kalyn You and Fatima Abbas *[Mentor: N. Siraj]*

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Flexible electronics have emerged as a transformative technology for next-generation applications in energy devices, sensors, displays, and biomedical systems. However, the development of high-performance, low-cost, and environmentally friendly electrode materials remains a significant challenge. In this study, the eco-friendly conductive polymer poly(3,4-ethylenedioxythiophene): poly(styrene sulfonic acid) (PEDOT: PSS) is incorporated with various ionic liquids (ILs) to enhance the electrical conductivity and mechanical flexibility of free-standing films. Inspired by the hard-soft acid-base (HSAB) theory, five ILs featuring systematically varied cation and anion hardness, including newly synthesized protic ILs are introduced to explore ion-specific effects on PEDOT: PSS performance. The films are fabricated via drop-casting and characterized using atomic force microscopy (AFM), scanning electron microscopy (SEM), x-ray photoelectron spectroscopy (XPS), four-point probe measurements, and tensile testing. Results show that protic ILs with a hard cation and soft anion significantly enhance conductivity and improve strain tolerance of the composite films as compared to the pristine PEDOT: PSS films. This study offers critical insights into the role of IL's ion selection in designing next-generation stretchable conductors for flexible electronics.

Analysis of Radio Observations of the April 8, 2024 Total Solar Eclipse at 1420MHz

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University of Central of Arkansas - Physics

We present analysis of data observed during the 08 April 2024 total solar eclipse from the University of Central Arkansas campus in Conway, Arkansas using a 2.3-m SPIDER 230C parabolic radio telescope tuned to a frequency of 1420 MHz. Initial analysis and simple theoretical models indicated that the radius of the radio sun was near 1.27 times the radius at visible frequencies, matching the minimum intensity seen during totality but not the rest of the data. In our current work, we aim to compare our observations with other universities to create a more accurate simulation that has a better agreement with observed lightcurves. Our goal is to create a model that is an accurate representation of the radio sun on the day of the eclipse.

Matchmaker: Human-AI Trust in Semantic Internship Allocation Systems

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John Brown University - Computer Science

Matchmaker is an AI-driven decision support system optimizing the allocation of software engineering interns to corporate projects. Beyond the technical implementation, the project serves as a research vehicle to investigate the trust gap between humans and AI, measuring how users interact with and validate high-confidence automated recommendations.

Internship programs often face a logistical bottleneck: mapping diverse applicant resumes to specific, evolving project requirements. Traditional keyword-based filtering often fails due to vocabulary mismatches, and human reviewers make errors, like missing matches in the details of a technical subfield. Furthermore, as organizations increasingly adopt AI to solve these problems, a new risk emerges: Automation Bias. We aim to gather data regarding the degree to which recruiters blindly trust AI recommendations, which can lead to failures in resource allocation if the AI logic is flawed.

This is a modular system that combines high-performance systems programming and advanced Natural Language Processing. We will fine tune a combination of off-the-shelf LLMs to structure resume data and create matches. Users upload input data and view the AI recommendations in a web app built on React and Supabase. The backend data pipelines are orchestrated with a high-performance API written in Rust.

The project will yield two primary outcomes: our Matchmaker artifact itself and the empirical findings which analyze our human-AI trust experiment.

The Natural Language Inference Abilities of a Large Language Model

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As Large Language Models (LLMs) see more use in daily life, it is important to know where their current shortcomings are when it comes to understanding human users. We investigated two things. One, how a pre-trained but not fine-tuned LLM can predict the context of sentences; Two, what part do prepositions play in that prediction. We conducted our experiment using a dataset of 10k related sentence pairs (a subset pulled from the MultiNLI corpus), one instance with prepositions present and another absent. We created a classification task to sort sentences into three categories (entailment, contradiction, or neutral) based on underlying mathematical representation created by the BERT LLM. We found that the resulting accuracy scores never eclipsed 49% on either dataset — hardly better than random guessing. Scores did not improve even after modifying our experimental pipeline. These findings told us an untuned BERT cannot adequately make context predictions. However, this was insufficient in answering our second question. Thus, we have redesigned our experiment on a fine-tuned model with frozen layers — results of which are forthcoming and will be presented in March.

Resampling-Enhanced Survival Analysis of Adjuvant Versus Neoadjuvant Therapies in Melanoma Using Kaplan-Meier Estimation, Weighted Log-Rank Tests, and Time- Dependent Cox Models

Joie Lea Murorunkwere *[Mentor: T. A. Famuyiwa]*

University of Arkansas—Little Rock - Mathematics

Background: Imbalanced clinical datasets can obscure true survival differences. This study evaluated how resampling methods affect survival comparisons between adjuvant and neoadjuvant melanoma therapies. Methods: SEER data were balanced using SMOTE, oversampling, under sampling, and bootstrapping. Outcomes were assessed via Kaplan-Meier estimators, weighted log-rank tests, and Cox models (standard and time-dependent). Results: Weighted log-rank tests showed significant survival differences in SMOTE ($\chi^2 = 68.2$, $p < 10^{-16}$). Cox models consistently confirmed higher hazards for neoadjuvant therapy ($HR = 2.3 - 2.7$, $p < 0.001$). Time-dependent models revealed diminishing treatment and age effects over time, highlighting dynamic risk structures. Conclusion: Resampling strategies enhance the detection and reliability of survival differences in imbalanced clinical datasets. Impact: Integrating resampling frameworks into oncology studies improves model robustness, balanced inference, and evidence for treatment efficacy.

Privacy-Preserving RAG System for Personal Document Question Answering

Kesava Manikanta Chirumamilla *[Mentor: M. A. Siddique]*

Arkansas Tech University - Computer Science | Engineering

This study introduces a fully on-premises privacy-preserving system using Retrieval-Augmented Generation (RAG) to address the challenge of accessing specific information from large collections of private documents. This represents a significant advancement in applying RAG for secure, local document question-and-answer applications, overcoming the privacy obstacles of conventional AI solutions. The proposed system combines a robust document ingestion pipeline using a Facebook AI Similarity Search (FAISS) vector store with an intelligent text generation mechanism orchestrated by the LangChain library, using a Llama 3 8B model for text generation. The model is served locally via Ollama, ensuring that no data leaves the user's environment. A key innovation is dynamic knowledge base management, which supports real-time document addition and deletion. Upon any modification, the system automatically rebuilds the vector index, ensuring that all subsequent queries are performed on a consistent and up-to-date knowledge state. The system's performance was evaluated using a dataset of 100 question-answer pairs across 20 diverse documents. The results highlight the system's effectiveness by achieving an accuracy of 89%, obtaining a BERTScore F1 of 87.19%, indicating strong semantic alignment, and reaching a ROUGE-L F1-Score of 70.75%11. The privacy-preserving claim was also empirically validated, promising a positive impact in sectors that require data security.

An AI based Avatar Assistant for John Brown University

Klei Nagode and Karol Becerra Moran *[Mentor: J. Selwyn]*

John Brown University - Computer Science

This project aims to relieve the pressure off faculty, staff and students by replacing common FAQs with a smart AI assistant trained on the JBU's data, providing 24/7 multilingual support.

Faculty, staff and students seek to find answers very common questions, especially when they are new to the campus. 'Stella AI' is a virtual assistant designed to support JBU students and faculty by providing quick and accurate information about the university and its website.

With the growing number of incoming students, faculty often face increased pressure to address repetitive questions. Implementing Stella AI helps alleviate this burden by offering 24/7 multilingual support, personalized responses, and a seamless user experience. In addition, Stella AI can collect valuable feedback and data to inform decision-making, reduce operational costs, and strengthen student engagement.

We expect to have a fully functional AI Chatbot and avatar assistant that is built on AI technologies, and uses OpenAI's LLM, Google's TTS-STT, and an Avatar design from other opensource platforms and services. The chatbot part is already finished with testing and integration is in progress. We expect this product to be integrated by the JBU ITS team and be gradually improved in the coming years.

By enhancing accessibility and convenience, this technology not only improves campus life but also serves as a strategic tool to attract new students and increase donations to the advancement department at JBU.

Establishing an On-Air Morse Code Corpus for Unbiased Evaluation of Deep Learning Decoders

Thomas Dodds, Anna-Marie Pesaresi, Paige Woolheater, Nicholas Colburn, and Chance Eoff *[Mentor: M. Birkenkahe]*

Lyon College - Computer Science | Mathematics | Data Science

Automatic detection of Morse Code (CW) signals has been a persistent challenge in signal processing since the communication method's inception in 1837. Past studies [1] have sought to advance digital signal processing techniques (DSP) for CW through machine learning and deep learning techniques; however, the models were evaluated with synthetically-generated datasets similar to what was used for training the models. While deep learning necessitates a large corpus, relying on the same materials for evaluation may be introducing considerable bias given the dynamic nature of the radio spectrum. Although deep learning necessitates large amounts of data for training models, this reliance on simulated data, particularly where evaluation is concerned, may fail to account for the sporadic properties inherent in real-world Radio Frequency (RF) environments, which may overstate the purported accuracy of these novel processing techniques. Furthermore, most popular transceivers are largely software-based and can introduce further bias via internal digital filtering and pre-processing that is common to most modern receivers1 [2]. The goal of this continued research is to construct and implement a minimal transceiver, paired with a dedicated auxiliary recording setup, for establishing a reliable corpus of real-world CW data to aid in the accurate evaluation of existing models, as well as to facilitate future signal analysis studies in this area.

Compositing Different Material Effects on Product Quality

Caleb Burnett *[Mentor: H. Zghair]*

Southern Arkansas University - Engineering

In a manufacturing environment where environmental variability and material reliability are crucial to customer satisfaction, robust quality assurance is essential. This research project, in collaboration with Southern Aluminum, focuses on comprehensive product life-cycle testing to evaluate durability, material integrity, and process control. By bridging classroom knowledge with real-world application, this collaboration exemplifies how undergraduate research can contribute to meaningful industrial innovation and enhanced customer satisfaction.

Impact of Dimensionality Reduction on Latent Document Geometry

Harrison Downs *[Mentor: Z. Stine]*

University of Central Arkansas - Computer Science

Dimensionality reduction is widely used in natural language processing to improve computational efficiency and mitigate the curse of dimensionality, yet its impact on the latent semantic spaces of document corpora remain unexplored. This study examines how dimensionality reduction alters latent document semantics and downstream task performance across multiple representation models and datasets. We analyze document embeddings from LSA, BERT, and GPT-2 applied to arXiv papers and Wine Spectator reviews, iteratively reducing dimensionality from 90% to 10% using SVD and deep autoencoders. To quantify semantic distortion, we compare pairwise document-document cosine similarity matrices before and after reduction using Pearson correlation and distributional statistics. Across datasets and models, linear reduction via SVD consistently preserves global similarity structure more effectively than nonlinear autoencoders, particularly at lower dimensionalities. Additionally, transformer-based representations exhibit greater robustness to dimensionality reduction than LSA. These trends are mirrored in downstream task performance (regression and multi-label classification), indicating that semantic distortions set in motion by dimensionality reduction correspond to measurable losses in task-relevant semantic structure. Altogether, these findings demonstrate that dimensionality reduction induces systematic, dataset-agnostic semantic changes that impact downstream task performance.

A Gaze-Aware XR Framework for Synchronizing Head-Based Interaction and Eye-Movement Analysis

Meherun Nesa Shraboni *[Mentor: A. Basu]*

University of Arkansas—Little Rock - Computer Science

Eye tracking is increasingly ubiquitous in modern extended reality (XR) head-mounted displays, offering opportunities to decode user attention and behavior during immersive interactions. However, most XR applications rely on head-pose or controller-based mechanics, while gaze data is collected separately for offline analysis. This separation obscures the critical relationship between gaze dynamics and the specific interaction events that drive task performance. To bridge this gap, we present a gaze-aware XR framework that synchronizes high-frequency eye tracking with head-based interaction in real time. Users navigate via a head-controlled cursor, while the system temporally aligns gaze streams with discrete events—such as cursor dwell, button activation, and scene transitions—with high precision. To enable scalable deployment without centralizing sensitive biometric data, we integrate a Federated Learning architecture. Each HMD trains locally, transmitting only model updates to a coordinating server running on a high-performance multi-GPU cluster. This approach keeps raw gaze and motion data strictly on-device. We further augment the server with secure aggregation, update clipping, and differential privacy to minimize information exposure. We detail the system architecture and synchronization strategy, demonstrating how this pipeline supports privacy-preserving observational studies and the development of adaptive, attention-aware interfaces across heterogeneous headsets.

Expectation of Pain: Effects on Threshold, Tolerance, and Perception of Pain

Emma Paulus and Aidan Donoho *[Mentor: J. Campbell]*

University of Arkansas—Fayetteville - Engineering

Brain activity in pain-related cortical regions is influenced by expectations and sensory input, yet expectation-driven pain perception is not well understood. This study used visual and auditory cues to set expectation levels and examined how unconscious expectations relate to experienced pain. With IRB approval, participants were randomly assigned to low or high expectation groups, completed surveys on expected and experienced pain, and received TENS stimulation with intensity increased every 15 seconds until pain tolerance or a 300-second limit was reached. Women in the high expectation group reported 36% higher expected pain (p=0.04), and expected and experienced pain were moderately correlated (ρ=0.331, p=0.014). Men in the low expectation group experienced 26.36% more pain (p=0.03) and had higher thresholds (94%, p=8.81×10^{-4}) and tolerances (63%, p=2.05×10^{-5}), though bicep diameter, significantly related to threshold (p=0.00369) and tolerance (p=0.0249), partially explained this. Expectation effects were strongest in women: those in the low expectation group had a 66% higher threshold (p=0.035) and 89% higher tolerance (p=0.012). Expected pain negatively correlated with threshold and tolerance (ρ=−0.332). These findings show that expectation and body composition shape pain perception.

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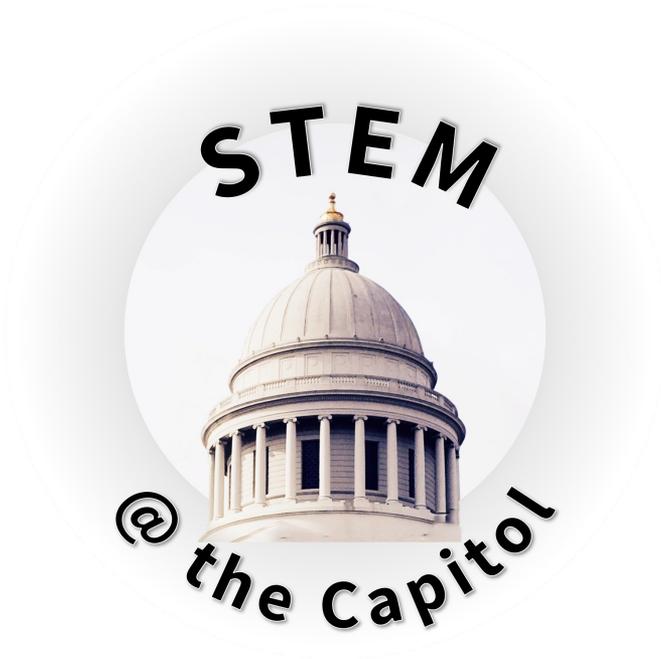
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