

Research is creating new knowledge



**2026 Summer Undergraduate
RESEARCH SHOWCASE**



MISSISSIPPI STATE
UNIVERSITY™

**Office of the Provost and
Executive Vice President**

P.O. Box BQ
3500 Lee Hall
Mississippi State, MS 39762

P. 662.325.3742
F. 662.325.4039

Mississippi State University: Our State's Land-Grant Research Flagship

We are honored to welcome you to Mississippi State University's Summer Undergraduate Research Symposium. Undergraduate students are an integral part of the multi-faceted research underway at Mississippi State.

Our faculty, staff, and students are conducting fundamental to applied research that provides innovative advancements, creative works, and new scholarship that address a range of pressing needs. As a result of this work, MSU is the leading institution in our state for research, which is a direct result of our embracing the land-grant mission. Strengths across all colleges and research centers have led to our institution being categorized by the Carnegie Foundation as a "very high research activity" institution. The Carnegie Foundation has also recognized Mississippi State with its Community Engagement Classification.

Pursuing research opportunities is a critical part of academic life on our campus, and our students are recognized for their commitment to discovery, creation, and exploration beyond the classroom. We are pleased that members of our faculty are dedicated to providing undergraduates with meaningful roles in the overall research enterprise and promoting interdisciplinary research as an important component of scholarly activity.

Undergraduate research gives our students opportunities to apply classroom knowledge to new areas of interest and helps them develop skills, collaborate with faculty and peers, and gain confidence. It is exciting to see the results of their efforts on display at today's symposium.

Again, welcome to the symposium, and thank you for your contributions to and interest in research at Mississippi State University.

David R. Shaw, Ph.D.
Provost and Executive Vice President

At Mississippi State, we believe in
the transformative potential of
university-based research.

We are proud of our undergraduate
researchers and the incredible
accomplishments on display at
today's symposium.

YOUR RESEARCH MATTERS!

We can't wait to see where it takes you.

HAIL STATE!

TAKING CARE OF WHAT MATTERS

Dr. Scott Willard
Interim Vice President
Research and Economic Development

@MaroonResearch



MISSISSIPPI STATE UNIVERSITY™
OFFICE OF RESEARCH AND
ECONOMIC DEVELOPMENT





MISSISSIPPI STATE UNIVERSITY™

UNDERGRADUATE RESEARCH AND CREATIVE DISCOVERY

Welcome to the Undergraduate Research Symposium

The Office of Undergraduate Research and Creative Discovery is pleased to co-host the Undergraduate Research Symposium and to be a part of Mississippi State University's Research Celebration. This symposium is a great way for undergraduate students to showcase their interest and dedication to research activities and for the MSU family to celebrate their engagement, curiosity, and hard work. Thank you for attending this exhibition!

This event is not possible without the time, effort, and assistance of our dedicated faculty mentors. The student work presented here represents many hours of mentoring students in their research, planning, and analysis. Many faculty and graduate students have also volunteered their time and expertise to serve as evaluators or judges, so thank you to all of them!

This event is an endeavor that relies on the support of countless individuals and sponsorship by many units, including but not limited to The Office of Research and Economic Development, The Graduate School, The Honor Society of Phi Kappa Phi, and Shackouls Honors College. We thank them for their commitment to helping make the Undergraduate Research Symposium a premier event.

We are pleased that fourteen Special Area Competitions are affiliated with the symposium to recognize excellence in scholarship and innovation. We are excited to partner with: Bagley College of Engineering; College of Agriculture and Life Sciences and Mississippi Agricultural and Forestry Experiment Station; College of Arts & Sciences Institute for the Humanities; College of Forest Resources and Forest and Wildlife Research Center; College of Education; Social Science Research Center; Center Data Science Program; Department of Agricultural and Biological Engineering and Department of Comparative Biomedical Sciences; Department of English; Department of Geosciences; Department of Psychology; the Graduate School; Gulf Scholars Program; Theta Tau Professional Engineering Fraternity; and Mitchell Memorial Library.

We are delighted that you have joined us today to honor the accomplishments of our young researchers. We hope you learn much from the diversity of fascinating research activities underway at MSU. Enjoy!

Anastasia D. Elder, Ph.D.
Associate Dean, Shackouls Honors College
Director, Office of Undergraduate Research & Creative Discovery

A&S RESEARCH

DISCOVERING WHAT MATTERS

The MSU College of Arts & Sciences is a proud sponsor of the MSU Undergraduate Research Symposium. Engaging in research plays a vital role in the academic culture of our college. Our students are celebrated for their dedication to exploration, innovation, and discovery outside traditional classroom settings. The involvement of undergraduates in research initiatives and advocating for interdisciplinary collaboration is a key aspect of scholarly endeavors.



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COLLEGE OF ARTS & SCIENCES



MISSISSIPPI STATE UNIVERSITY™
— JAMES WORTH —
BAGLEY
COLLEGE OF ENGINEERING



BCOE RESEARCH

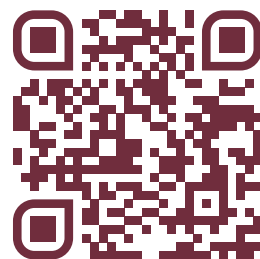
Make your impact by conducting groundbreaking research. As a BCoE student, you will work alongside your professors as they look to the future, discovering solutions to the world's most urgent problems. Interested in preventing traumatic brain injuries? Creating autonomous systems? Dream of designing groundbreaking machinery? The college has facilities to conduct a wide variety of design, analysis and testing. It works with a wide variety of MSU centers, such as the Center for Advanced Vehicular Systems (CAVS), the High Performance Computing Collaboratory (HPC²) and many others.

**OVER \$66.8 MILLION
IN RESEARCH
EXPENDITURES
(FY24)**

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THROUGH UNDERGRADUATE RESEARCH

Collaborate with faculty and industry partners to explore entrepreneurship, markets and innovation.

Undergraduate Research Opportunities:



MILO – Market Innovation Lab & Observatory

Advanced marketing research using eye-tracking, facial recognition and consumer behavior analysis.



COFER – Center of Family Enterprise Research

Study succession, governance, and sustainability in family-owned businesses.



E-Center – Center for Entrepreneurship & Outreach

Turn ideas and research discoveries into real-world startups and innovations.



MISSISSIPPI STATE UNIVERSITY™
COLLEGE OF BUSINESS

business.msstate.edu



In our four academic units across CAAD, research and creative scholarship are inseparable from the act of making. Our undergraduates help design resilient communities, exhibit original artwork, build with emerging technologies, and shape the spaces where people live and work. Whether through studio practice, fieldwork, or community-engaged design, CAAD students don't just study problems - they design and implement solutions.

Our research centers - the Fred Carl Jr. Small Town Center, the Gulf Coast Community Design Studio, and the Jackson Community Design Center - connect students to real-world challenges in communities across Mississippi and the Gulf South. CAAD undergraduates present at national conferences, compete in juried exhibitions, and contribute to funded research alongside faculty mentors.

Start your research journey at caad.msstate.edu and work with faculty who bring expertise from across the globe.





COLLEGE OF AGRICULTURE
AND LIFE SCIENCES



UNDERGRADUATE
RESEARCH SCHOLARS PROGRAM





MISSISSIPPI STATE UNIVERSITY™
COLLEGE OF EDUCATION



MAKING AN IMPACT

In Mississippi State University's College of Education, we are translating knowledge into impact. In fiscal year 2025 we were awarded **\$20.8 million for research**. We're inspiring others to explore their passions through five academic departments, a division of education, one research unit and numerous service units. Learn more about the centers and institutes housed in our college below and at educ.msstate.edu.

College of Education Faculty Labs

The College of Education's academic units house a number of faculty-led research labs that provide **hands-on learning opportunities for students**. The labs include human health and performance, academic and behavior intervention, along with artificial intelligence and virtual reality applications in industry and design.

Mississippi Institute on Disabilities

The Mississippi Institute on Disabilities focuses on support and opportunity for people with disabilities in our state. Including **MSU's T.K. Martin Center for Technology and Disability, Autism and Developmental Disabilities Clinic and Career Horizons Center**, the institute creates a hub for research, training and collaboration.

National Research & Training Center on Blindness & Low Vision

The National Research and Training Center on Blindness and Low Vision is the nation's **only federally funded center focused on employment outcomes for people who are blind or have low vision**. The center produces field-leading research and provides training to professionals.



Congratulations to
our Undergraduate
Research Scholars
Program participants!





MISSISSIPPI STATE UNIVERSITY™
COLLEGE OF VETERINARY MEDICINE

vetmed.msstate.edu



THE OFFICE OF PRESTIGIOUS EXTERNAL SCHOLARSHIPS



The Office of Prestigious External Scholarships mentors all Mississippi State University students who apply for national and international scholarships, fellowships, and awards. We work with students to find scholarships that fit their academic and professional aspirations and we help students develop competitive, compelling applications.

Each year, we work with dozens of Mississippi State University students and alumni from a wide variety of backgrounds, areas of study, and interests. We help them to not only develop strong applications to their desired scholarships and fellowships but also to craft strong personal narratives that can be applied beyond external scholarship applications.

Since the office's inception in 2012, Mississippi State has had a Rhodes Scholar, a Churchill Scholar, a Gates Cambridge Scholar, a Marshall Scholar, four Truman Scholars, fourteen Fulbright Scholars, six Boren Scholars, sixteen Astronaut Scholars, eleven PPIA JSI winners, fourteen Goldwater Scholars and more!

UNDERGRADUATE/ NATIONAL

- Astronaut Scholarship
- Goldwater Scholarship
- Udall Undergraduate Scholarship
- Public Policy and International Affairs Junior Summer Institute
- Humanity in Action Fellowship
- Hollings NOAA Scholarship

INTERNATIONAL

- Fulbright U.S. Student Awards
- Fulbright U.K. Summer Institute
- Boren Awards
- Critical Language Scholarship
- DAAD - Rise
- Voyager Scholarship

GRADUATE SCHOOL

- Knight-Hennessy Scholar Program
- Truman Scholarship
- Rhodes Scholarship
- Gates-Cambridge Scholarship
- Marshall Scholarship
- Mitchell Scholarship
- Churchill Scholarship
- Rangel Fellowship

**ARE YOU INTERESTED IN APPLYING TO AN EXTERNAL SCHOLARSHIP?
SCHEDULE A MEETING!**

For appointments regarding specific scholarships, application processes, or editing of polished essays, please contact Dr. David Hoffman, Director of OPES.



THE HONOR SOCIETY OF PHI KAPPA PHI

Chapter 060
Mississippi State University
Mississippi State, MS 39762



RE: The Undergraduate Research Symposium

Dear Undergraduate Research Symposium Participants:

The Honor Society of Phi Kappa Phi (PKP) has a long and distinguished history. Currently, there are over 300 chapters of PKP scattered all across the world, from Maine to Hawaii and the Philippines, and from Alaska to Puerto Rico and beyond. During the 1996 – 97 academic year, PKP celebrated the 100th anniversary of the founding of The Honor Society of Phi Kappa Phi, and we are now in the second century of its recognition of- and service to - learning. The MSU chapter celebrated its 70th year of membership in 2021 and consists of 770 active members at present. PKP invites only the highest achieving students from across all disciplines to join this prestigious society and induct new members each spring and fall into the Honor Society. Due to PKP's prestigious recognition and support of learning, the MSU Chapter is proud to support the 2026 Undergraduate Research Symposium at Mississippi State University. As Chapter President, I am honored that Phi Kappa Phi has been asked and is able to support this event as I have tremendous respect for undergraduate research at MSU. This symposium displays the importance of research for success as a student and beyond! Undergraduate research meets a very important criteria of ensuring that every student engages in some form of experiential learning while attending the university.

Thank you for all you do to support undergraduate research opportunities at Mississippi State University,

Respectfully,

Joshua Granger, PhD, MSU PKP Chapter President

Josh Granger
President
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MS State, MS
39762

Krishna Poudel
Vice President
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Congratulations,
and thank you for making
the Undergraduate
Research Symposium a
success!

WE ARE
SO PROUD
OF YOU!



MISSISSIPPI STATE UNIVERSITY™
JUDY AND BOBBY SHACKOULS
HONORS COLLEGE

JULY 30, 2026 | 10:00AM – NOON

The names in this table are listed alphabetically by category, while the abstracts within the book are completely alphabetical.

BIOLOGICAL SCIENCES		
Felix Afiat	001	<i>Biological Sciences</i>
Cassandra Allen	002	<i>Biochemistry</i>
Dilber Annageldiyeva	003	<i>Biochemistry</i>
Emma Baker	004	<i>Environmental Science in Agri. Systems</i>
Maya Basnyat	005	<i>Environmental Science in Agri. Systems</i>
Miranda Benson	006	<i>Biological Sciences</i>
Marion Brown	007	<i>Computer Science</i>
Jocalyn Cruz-Sanders	008	<i>Biochemistry</i>
Jules Davis	009	<i>Forestry</i>
Blake Fisher	010	<i>Forestry</i>
Fernando Guapo Ereno	011	<i>Agronomy</i>
Kate Hull	012	<i>Biological Sciences</i>
Lauren Jeffrey	013	<i>Forestry</i>
Audrey Jenkins	014	<i>Biological Sciences</i>
Willie McGee	015	<i>Horticulture</i>
Portia Mobley	016	<i>Biological Sciences</i>
Oanh Nguyen	017	<i>Chemistry</i>
Mo Ouren	018	<i>Forestry</i>
Ayla Ray	019	<i>Biological Sciences</i>
Morgan Sheffield	020	<i>Biochemistry</i>
Jayla Singleton	021	<i>Biochemistry</i>
Matthew Smith	022	<i>Biochemistry</i>
Emily Snodgrass	023	<i>Biochemistry</i>
Jack Taylor	024	<i>Horticulture</i>
Ellianna Uldrich	025	<i>Biological Sciences</i>
Kritika Upadhyay	026	<i>Computer Science</i>
Mahmoud Yusuf	027	<i>General Science</i>
BUSINESS AND ECONOMICS		
Taylor Shackleford	028	<i>Business Management</i>
EDUCATION		
Charles Hayes	029	<i>Secondary Education</i>
ENGINEERING		
Aubrey Anderson	030	<i>Computer Science</i>
Prashant Bhattarai	031	<i>Mechanical Engineering</i>

Charles Bloss	032	<i>Industrial Engineering</i>
Emmanuel Braimah	033	<i>Aerospace Engineering</i>
Ella Britt	034	<i>Biosystems Engineering</i>
Andrew Buchanan	035	<i>Mechanical Engineering</i>
Luther Busching	036	<i>Mechanical Engineering</i>
Katie Chung	037	<i>Mechanical Engineering</i>
Camila Da Silva	038	<i>Computer Science</i>
Joseph Dooley	039	<i>Industrial Engineering</i>
Mandy Dreznick	040	<i>Industrial Engineering</i>
Esther Edwards	041	<i>Chemistry</i>
Chimereze Emenike	042	<i>Mechanical Engineering</i>
Kavya Gautam	043	<i>Computer Science</i>
Dustin Gavins	044	<i>Industrial Engineering</i>
Niranjan Giri	045	<i>Computer Engineering</i>
Davis Haliburton	046	<i>Electrical Engineering</i>
Anika Housna	047	<i>Industrial Engineering</i>
Rikhi Joseph	048	<i>Computer Engineering</i>
Roshan Katta	049	<i>Computer Science</i>
Gilliam Londa	050	<i>Mechanical Engineering</i>
Ashwani Kumar Mishra	051	<i>Computer Science</i>
Matthew Muhlestein	052	<i>Computer Science</i>
Vivian Nguyen	053	<i>Computer Science</i>
Chinwuba Nwokoye	054	<i>Computer Science</i>
Haley Orr	055	<i>Computer Engineering</i>
Elizabeth Orton	056	<i>Biomedical Engineering</i>
Wesley Owens	057	<i>Industrial Engineering</i>
Kayla Pigott	058	<i>Industrial Engineering</i>
Shriya Rajan	059	<i>Chemical Engineering</i>
Anna Robinson	060	<i>Computer Science</i>
Reeves Rogers	061	<i>Physics</i>
Erfan Sadri	062	<i>Computer Science</i>
Asahi Lama Sherpa	063	<i>Computer Science and Mathematics</i>
Shivani Shodhan	064	<i>Mathematics</i>
Paulo Sergio Silva	065	<i>Electrical Engineering</i>
Adi Singh	066	<i>Computer Science</i>
Pengfei Sun	067	<i>Mathematics</i>
Cole Thibodeaux	068	<i>Industrial Engineering</i>
Parker Toney	069	<i>Electrical Engineering</i>
Mai Viet Tan Tran	070	<i>Industrial Engineering</i>
Somin Upadhyaya	071	<i>Computer Science</i>
Guhan Vel	072	<i>Industrial Engineering</i>
Quinton Wiley	073	<i>Sustainable Bioproducts</i>

Michael Wloch al	074	<i>Physics</i>
Max Yagel	075	<i>Computer Science</i>
Sunny Zhen	076	<i>Electrical Engineering</i>
Itziar Zubeldia	077	<i>Computer Science</i>
PHYSICAL SCIENCES		
Aiden Bennett	078	<i>Physics</i>
Brian Blanchard	079	<i>Chemistry</i>
Autumn Brock	080	<i>Chemical Engineering</i>
Edith Domanski	081	<i>Chemistry</i>
Medha Fotedar	082	<i>Physics</i>
Asiyon Hudson	083	<i>Physics</i>
Eric Jones	084	<i>Chemistry</i>
Jeseny Lewis	085	<i>Chemistry</i>
Mary Pittman	086	<i>Mathematics</i>
Atharva Shastri	087	<i>Chemical Engineering</i>
Daniella Unpingco	088	<i>Chemistry</i>
Heather Weston	089	<i>Chemical Engineering</i>
Jane Williams	090	<i>Physics</i>
SOCIAL SCIENCES		
Tristan Brewer (<i>oral pres.</i>)	091	<i>Secondary Education</i>
Victoria Brown	092	<i>Psychology</i>
Robert Culwell	093	<i>Agricultural Engineering Technology & Business</i>
Julius Culwell	094	<i>Agricultural Education, Leadership & Comm.</i>
Royal Katuwal	095	<i>Economics</i>
Ian Robertson	096	<i>Criminology</i>



BIOLOGICAL SCIENCES

001: AFIAT, FELIX

Major: Biological Sciences - Bachelor of Science

University: University of Florida

Faculty Research Mentor: Heidi Renninger, Forestry

Co-Authors: Heidi Renninger

Funding: NSF REU: Forestry

Project Category: Biological and Life Sciences

Factors influencing understory plant species diversity in recently burned upland pine forests

Prescribed fire is vital to the maintenance of upland pine forest ecosystems in the southeastern United States. Many plant species native to these forests are fire-dependent. Fire may increase plant species diversity in the understory of upland pine forests by increasing soil nutrient availability, clearing the midstory of vegetation, and preventing light-demanding species from being shaded out. Frequent burning has been shown to increase species richness in pine ecosystems. The link between years since burned and species diversity is less certain. Aside from fire, many other factors may influence plant biodiversity, including canopy structure, stand basal area, and soil type. We measured several fire-related and fire-unrelated factors, specifically, years since burned, burn intensity, canopy structure, and soil type, to determine their impact on understory plant species diversity in upland pine forests in Mississippi. We measured loblolly pine forest stands in the John Starr Memorial Forest and Noxubee National Wildlife Refuge in northeastern Mississippi that had been burned this past spring and up to three years ago. Species diversity was measured by randomly sampling quadrats of the forest floor and identifying every understory species inside each. Burn intensity was estimated by measuring the height of the burn marks on the pines. Light detection and ranging (LiDAR) was used to estimate leaf area index (LAI), canopy cover, and gap fraction. We found significant positive correlation between Shannon diversity index and burn height and negative correlation between Shannon diversity index and LAI. Years since burned, canopy cover, and gap fraction all showed no correlation. Data will be further analyzed using multiple linear regression and principal component analysis.

002: ALLEN, CASSANDRA

Major: Biochemistry - Bachelor of Science

Faculty Research Mentor: Florencia Meyer, Department of Biochemistry, Nutrition and Health Promotion

Co-Authors: Florencia Meyer

Funding: College of Agriculture and Life Sciences URSP

Project Category: Biological and Life Sciences

Designing a biofilm assay for *Mannheimia haemolytica*

Bovine Respiratory Disease (BRD) is a respiratory illness that affects cattle and involves viruses, bacteria, and environmental stress factors. One of the microbes that contributes to BRD is a commensal bacterium that lives in the respiratory tract of bovines, called *Mannheimia haemolytica*. When *M. haemolytica* translocates to the trachea or the lungs it can form a biofilm. A biofilm is a bacterial aggregate that assists the organisms in adhering to its environment, increasing their chances of survival, while also making them impervious to toxic agents or antibiotics due to the biofilm's gelatinous makeup. The goal of this study is to find a method to reduce or disrupt the biofilm formation in vitro. We are currently utilizing laboratory detergents, such as Tween 20 or Triton X-100, to disrupt the formation of the biological aggregate. This would serve as an ideal negative control for our biofilm assays.

003: ANNAGELDIYEVA, DILBER

Major: Biochemistry - Bachelor of Science

Faculty Research Mentor: Galen Collins, Biochemistry, Nutrition & Health Promotion

Funding: College of Agriculture and Life Sciences URSP

Project Category: Biological and Life Sciences

Functional Analysis of Human Retroviral-Like Protease Domains in Yeast Protein Quality Control and Secretion

Protein homeostasis depends on pathways that recognize, traffic, and degrade misfolded or damaged proteins. Ddi1

is a conserved ubiquitin-associated protein containing a retroviral-like protease (RVP) domain and is linked to proteasome-associated protein quality control and secretion. However, the conservation of RVP-domain function between yeast and human proteins is not fully understood. This project tests whether human RVP-containing or RVP-like proteins can complement yeast DDI1 and suppress secretion defects in a Δ ddi1 yeast background. Candidate human proteins, including DDI2-related sequences and RVP-associated proteins such as ASPRV1, NRIP3, NRIP2, PEG10, and RTL1, will be cloned into yeast expression vectors. Inserts will be amplified by PCR, digested with compatible restriction enzymes, ligated into plasmids, transformed into *Escherichia coli*, purified by miniprep, and validated before transformation into Δ ddi1 yeast. Functional rescue will be evaluated by measuring Kap2p secretion as a readout of protein trafficking and secretion. This study will help determine whether human RVP-like proteins can restore Ddi1-related function in yeast and may support the development of a yeast-based system for studying human proteostasis factors.

004: BAKER, EMMA

Major: Environmental Sci in Ag System - Bachelor of Science

University: Nova Southeastern University

Faculty Research Mentor: Rajeev Bhattarai, Department of Forestry

Funding: NSF REU: Forestry

Project Category: Biological and Life Sciences

Exploring Remote Sensing Indicators of Bark Beetle Induced Forest Stress

Forest pest insects, particularly bark beetles, are capable of causing extensive ecological and economic damage to the forestry industry. With climate change responsible for escalating environmental disturbances, like drought or flooding, trees are increasingly vulnerable to these pests, and as winters grow milder, their geographical range is expanded which exposes new forests. The southern pine beetle (*Dendroctonus frontalis*) is a prominent bark beetle in the southern United States, especially in Mississippi, Alabama, and Georgia. This insect is a bark-boring beetle that, during periods of outbreak, can wipe out massive numbers of trees. This study aimed to better understand the rate at which bark beetles can affect a forest and determine efficient methods of identifying damage caused by them. The application of remote sensing in the field of forestry has been found to make surveying of large areas of land quicker and require much less labor compared to the traditional ground surveying techniques. Therefore, multispectral satellite imagery was utilized to analyze pest-induced forest stress in the Tombigbee National Forest in Louisville, Mississippi. The Normalized Difference Vegetation Index (NDVI) and Normalized Difference Moisture Index (NDMI), including temporal differences of them, were calculated using R-Programming, and this was overlaid with the US Forest Service Detection Survey dataset. The results of the study found an unexpected dip in NDVI and NDMI, which does coincide with seasonal emergence of the southern pine beetles after the winter season. In areas with known locations of southern pine beetle outbreaks, NDVI and NDMI were seen to be lower, indicating that the stress impact of southern pine beetles on a forest can be seen using satellite imagery.

005: BASNYAT, MAYA

Major: Environmental Sci in Ag System - Bachelor of Science

University: University of Richmond

Faculty Research Mentor: Adam Polinko, Forestry

Co-Authors: Adam Polinko

Funding: NSF REU: EMRAF (Forestry)

Project Category: Biological and Life Sciences

Do Extreme Weather Events Drive Emergent Patterns of Stand Dynamics?

Self-thinning occurs as a natural function of the density within a stand and the $3/2$ power law provides a predicted relationship between the weight of a tree proportional to the 2.5th power of DBH (Yoda et al., 1963). Although our understanding of self-thinning boundaries have been known for nearly a century, little is known about the mechanisms that drive these relationships and how they may vary through time. Preliminary analysis suggests that as stand density increases, competition leads to more self-thinning which results in lower total biomass compared to less dense stand, a phenomenon known as the crossover effect. This project looks empirically at climate-induced self-thinning and aims to identify the mechanism for that mortality through dendrochronological forensics while also

examining the role of genotype variation in growth using a loblolly pine spacing trial established in 1985 at three different densities (435, 680, and 1,742 trees per acre). Increment cores were collected from a subset of surviving trees, processed according to standard dendrochronological procedures, and dated using the Coorecorder and CDendro dendrochronology software. We will present results describing the role of extreme weather and genetics on the emergent property of self-thinning and discuss the implications of identifying self-thinning thresholds on managing forest stands as complex adaptive systems. Ultimately, these results may have significant implications for our underlying understanding of stand dynamics and ability to harness forests as climate solutions.

006: BENSON, MIRANDA

Major: Biological Sciences - Bachelor of Science

Faculty Research Mentor: Ashley Schulz, Department of Forestry

Co-Authors: Ashley Schulz

Funding: NSF REU: Forestry REU

Project Category: Biological and Life Sciences

Differences in Defoliator Damage Between Native and Non-Native Woody Plants

Non-native species are rapidly taking over many southeastern states and causing economic and ecological damage, such as outcompeting native species and changing natural disturbance regimes. Non-native plants, such as Chinese tallow tree (*Triadica sebifera*) and Bradford pear (*Pyrus calleryana*), have been introduced as ornamental plants and can produce thousands of seeds per year that can be rapidly spread by animals or water. Many hypotheses have been developed to try to explain how non-native species successfully establish, spread, and cause impact in a novel range. For example, invasive plants may escape herbivores in their native range through enemy release or reduction, although, conversely, herbivores in the novel range can limit invasion through biotic resistance. The objective of this study is to assess and compare herbivore damage on native and non-native woody plants from nine sites total in Alabama (Auburn, Birmingham, Montgomery), Georgia (Athens, Atlanta, Augusta), and Mississippi (Columbus, Starkville, Winona). Mississippi sites were visited in Fall 2023 and Spring 2024, and Alabama and Georgia sites were visited in Spring and Fall 2025. Pruners were used to collect twigs with leaves from three native (*Acer rubrum*, *Liquidambar styraciflua*, *Quercus nigra*) and three non-native (*Elaeagnus pungens*, *Pyrus calleryana*, *Triadica sebifera*) woody plant species at each site. Twigs were pressed and dried, then 30 leaves were randomly sampled from each tree specimen and scanned using LeafByte to quantify percent defoliation. Preliminary results demonstrate differences in leaf defoliation, where native plant species have higher defoliation than introduced woody plant species.

007: BROWN, MARION

Major: Computer Science - Bachelor of Science

University: Mississippi Gulf Coast Community College

Faculty Research Mentor: Seth Givens, Agricultural and Biological Engineering (ABE)

Co-Authors: Seth Givens

Funding: ORED Undergraduate Research Program

Project Category: Biological and Life Sciences

Comparing PlantEye Measurements with Manual Measurements in Soybean Plants

PlantEye is a plant phenotyping system that can measure plant traits without damaging the plant. The purpose of this project was to compare PlantEye measurements with field and manual measurements to determine how well they relate to one another and whether PlantEye can be used as a reliable alternative for collecting plant data. Data from soybean plants were analyzed using Python. The main PlantEye measurements used in this study were NDVI, NPCI, 3D leaf area, and plant height. Linear regression and correlation analyses were used to compare PlantEye measurements with field measurements, including manually collected plant height data. This produced values such as R^2 , RMSE, and MAE, which were used to evaluate the relationships between measurements. Initial results showed a relationship between PlantEye height measurements and manually measured plant height. Additional analyses were performed to examine the relationships between NDVI, NPCI, 3D leaf area, and plant height. These results suggest that PlantEye measurements can provide useful information about soybean growth and plant characteristics. This project demonstrates the potential of using PlantEye technology as a faster and more efficient method for collecting plant

measurements. By reducing the need for manual measurements, PlantEye may help researchers collect data more quickly while still providing accurate results for soybean research and plant phenotyping studies.

008: CRUZ-SANDERS, JOCALYN

Major: Biochemistry - Bachelor of Science

Faculty Research Mentor: Richard Baird, Agricultural Science and Plant Protection;

Co-Authors: Richard Baird, Ryan Williams

Funding: NSF REU: 2447730

Project Category: Biological and Life Sciences

ROS Enzymes for Breeding Disease Resistance in American Chestnut and White Oak Trees.

The Fagaceae family of hardwood trees are historically known for their industrial use, such as white oak (*Quercus alba*), for barrels used in the production of legal bourbon. The white oak population has dwindled significantly due to various environmental factors, including disease and poor natural regeneration. The American chestnut (*Castanea dentata*), once a keystone species vital to wildlife and humans for its chestnut production and strong wood, is considered functionally extinct, with much of the steep decline attributed to chestnut blight disease (*Cryphonectria parasitica*). Breeding for disease resistance using traditional methods has been challenging, as it takes years for field trials to evaluate new seedling greenhouse lines. Using a newer approach, biochemical signatures can be identified in seedling progeny to detect disease resistance markers. Reactive oxygen species (ROS) are metabolites that accumulate when an organism experiences environmental or biological stressors. At low concentrations, it can initiate a protective response, but at higher levels, it can cause further damage to the organism at the cellular level. When the response is to protect the organism, it can cause the infected portions of the tree to die, preserving the remaining healthy plant tissue. In this study, the enzymatic activities were assessed to determine the potential role of ROS in hardwood tree immune responses. Key ROS could serve as biomarkers for identifying disease tolerance for use in breeding efforts, saving years of time and labor costs compared to current efforts to reestablish the American chestnut or white oak.

009: DAVIS, JULES

Major: Forestry - Bachelor of Science

University: Middlebury College

Faculty Research Mentor: Joshua Granger, Forestry

Funding: NSF REU: Forestry under Dr. Granger

Project Category: Biological and Life Sciences

Effects of Oxygen Availability on Bald Cypress (*Taxodium distichum*) Seedling Growth Under Flooded Conditions

Bald cypress (*Taxodium distichum*) is an ecologically valuable bottomland species in the southeastern United States. While these species are regarded for their flood tolerance, the impact of flooding on the growth and physiology of bald cypress is not well understood. Prior research suggests a positive relationship between precipitation and radial increment, suggesting that growth may be associated with increased dissolved oxygen levels surrounding the roots of the tree under flooded conditions or through bark and leaf moisture exchange with the atmosphere. We conducted a greenhouse study of 108 bald cypress seedlings grown in 18 storage totes under three different treatments that consist of inundated with supplemental oxygen, inundated without supplemental oxygen, and a control well water, non-inundated conditions, as well as under mist and non-mist conditions. To understand the impact of root oxygenation and misting on bald cypress growth, we measured pre- and post-treatment plant heights and root collar diameters, dissolved oxygen levels, water temperatures, chlorophyll fluorescence, and photosynthetic rates. We will present results on the role of dissolved oxygen and misting on bald cypress growth and physiology and discuss how this research provides greater insight into how bald cypresses grow under flooded conditions. Ultimately, this research will inform policymakers and land managers towards improving wetland restoration and conservation.

010: FISHER, BLAKE

Major: Forestry - Bachelor of Science

University: Goshen College

Faculty Research Mentor: Krishna Poudel, Forestry

Co-Authors: Krishna Poudel, Ashley Schulz

Funding: NSF REU: Ecology and Management for Resilient and Adapted Forests

Project Category: Biological and Life Sciences

Evaluating Low-Cost LiDAR Platforms for Measuring Carbon Sequestration in Urban Forestry

Light Detecting and Ranging (LiDAR) technology has been increasingly used in measuring forest carbon sequestration in recent years. Accordingly, methods to improve efficiency have been investigated for different LiDAR systems. However, most of the research focuses on high-end applications of the hardware, leaving a gap regarding cost-effective options. This study investigates the accuracy of two lower-cost LiDAR solutions against traditional forestry measurements -- a handheld LiDAR system, the LiGrip 01 Lite developed by Greenvalley Inc., and a cell phone LiDAR sensor found in the iPhone 16 Pro. Using mean absolute percentage error (MAPE) as the primary validation metric, we assessed the device's ability to accurately capture and measure tree geometry with the goal being to measure aboveground biomass (AGB). Analysis of the LiGrip 01 Lite exhibited high variability across datasets; while showing high accuracy on select trees, it shows extreme fluctuations across the samples. Ongoing testing of the iPhone 16 Pro's sensors is expected to show similar results, with potentially significant improvements in results due to increased ease of use with the program. This analysis highlights the trade-offs between hardware affordability and data reliability within the LiDAR sphere.

011: GUAPO ERENO, FERNANDO

Major: Agronomy - Bachelor of Science

Faculty Research Mentor: Raju Bheemanahalli Rangappa, Department of Plant and Soil Sciences

Co-Authors: Bala Subramanyam Sivarathri, Chami Rampati Dewage, Raju Bheemanahalli

Project Category: Biological and Life Sciences

Impact of Seed Size and Composition on Soybean Seedling Development

Soybean (*Glycine max*L.) is one of the world's leading agricultural commodities, valued for its protein and oil content. Our earlier research indicated that resources allocated during grain filling influence seed weight and quality, including protein and oil. Notably, intra-generational variation in seed quality can establish a memory effect, either advantageous or detrimental, that affects subsequent generations' performance. We hypothesize that, under stress, high-protein seeds may act as molecular chaperones, thereby enhancing seedling vigor. In this study, we employed near-infrared spectroscopy (NIRS) to assess protein variability across 220 soybean genotypes. Protein content varied substantially, ranging from 39% to 51% on a dry weight basis, with a mean of 51%. Approximately 44% of the genotypes recorded protein levels below 44%, specifically within the 39.1% to 43.8% range. Oil concentrations ranged from 14% to 24%, with an average of 19%. Protein content was significantly and negatively correlated with oil content ($r = -0.53$, $P < 0.01$). Seeds with known quality (protein and oil) were germinated under low and high temperatures to assess the impact of seed protein content on seedling vigor traits, including root and shoot biomass. Individual seed weight positively correlated with shoot growth under high ($r=0.33$, $P<0.01$) and low temperatures ($r=0.40$, $P<0.01$). Oil content showed weak positive correlations with shoot weight under high and low temperatures, but no significant correlation with root weight. Protein content was not significantly associated with shoot or root weight under either condition, indicating that seed protein variation did not affect seedling growth.

012: HULL, KATE

Major: Biological Sciences - Bachelor of Science

University: Drury University

Faculty Research Mentor: Ashley Schulz, Department of Forestry

Co-Authors: Susan B. Adams, Courtney M. Siegert, Joshua J. Granger

Funding: NSF REU: Forestry

Project Category: Biological and Life Sciences

Burrowing Crayfish Effects on Soil Properties and Plant Communities in Mississippi Prairie and Forest Ecosystems

Mississippi has a diverse array of freshwater crayfish species, including aquatic and burrowing crayfish species. There is little known about some burrowing species, such as Egyptian Crayfish (*Procambarus hagenianus vesticeps*), which are endemic to eastern Mississippi and can be found in a variety of ecosystems, including urban green spaces, prairies, and savannas. Secondary and tertiary burrowers primarily live in surface waters and dig burrows in response to seasonal drought, whereas primary burrowers dig complex branching tunnels to reach the water table and rarely enter open surface waters. Some burrowing species build tall chimneys around the burrow using soil from in and around the hole, potentially intermixing the soil horizons and impacting plant communities. This study aimed to uncover how burrowing crayfish are impacting the soil and vegetation surrounding their burrows to better understand their impacts in terrestrial ecosystems. Crayfish burrows were identified at four sites including an urban prairie, a pine savanna, a bottomland hardwood forest, and a pine forest. At each site, three burrows located at least 2m apart and one randomly selected control plot were sampled. A quadrat was placed around each burrow and control to estimate plant cover and identify plant species on and around the burrow or control. At each of the burrows and controls, 20cm soil cores were taken using a soil probe at 5cm, 10cm, 20cm, and 40cm on two sides from the center of the burrow or control. Soil properties, such as available nitrogen, organic matter, pH, and electrical conductivity, were assessed. Results of this study will be discussed in the context of natural resource impacts and management.

013: JEFFREY, LAUREN

Major: Forestry - Bachelor of Science

University: Michigan Technological University

Faculty Research Mentor: Ram Adhikari, Forestry

Funding: NSF REU: Forestry REU

Project Category: Biological and Life Sciences

Influence of Stand Structure on Disturbance Resistance and Resilience in Mississippi Forests

Mississippi contains some of the most productive forest ecosystems in the United States, with forests covering approximately 62% of the state's land area as of 2024. The forest products industry also plays a key role in the state's economy, contributing an estimated \$15.44 billion annually. However, climate change is altering disturbance regimes and forest dynamics through changes in growing season length, precipitation patterns, temperature, and the frequency of extreme weather events. These changes are also associated with increases in invasive species, pathogens, and insect outbreaks, all of which have the potential to reduce forest productivity and carbon sequestration. As a result, forest management strategies are evolving to improve forest resistance and resilience to future disturbances. The goal of this project is to provide the background for a future climate adaptation management project in Mississippi. To accomplish this, we are using the U.S. Forest Service Forest Inventory and Analysis (FIA) database and the Mississippi Forest Inventory (MIFI) dataset to identify and characterize disturbance histories across the state. The Forest Vegetation Simulator (FVS) is being used to model tree growth and estimate resistance and resilience following disturbance. Stand density and diversity indices will also be evaluated to examine how forest composition and structure may influence a stand's ability to withstand and recover from disturbances. The results of this project are expected to help identify forest conditions that may be better suited to future climate adaptation and management efforts in Mississippi.

014: JENKINS, AUDREY

Major: Biological Sciences - Bachelor of Science

Faculty Research Mentor: Matthew Brown, Biological Sciences

Co-Authors: Felicity Kleitz-Singleton, Matthew W. Brown

Funding: Shackouls Honors College Research Fellowship

Project Category: Biological and Life Sciences

Getting to the root of things: *Vannella fimicola* as a developmental model to uncover the transcriptional dynamics and evolutionary origins of sporocarpic fruiting in Amoebozoa

Sporocarpic fruiting is a developmental process in which a single amoeboid cell produces one to many spores on an acellular stalk. This trait has been found to be distributed across multiple amoebozoan lineages and is thought to be an evolutionary innovation unique to Amoebozoa. Despite the knowledge where it evolved amongst the group, its

molecular basis and evolutionary origins remain poorly understood. *Vannella fimicola*, a terrestrial amoebozoan and the only known member of the family Vannellidae to exhibit a sporocarpic life cycle, provides an ideal model system for investigating this developmental process due to its simplistic life history, ease of cultivation, and reliable fruiting under laboratory conditions. This project aims to establish a developmental transcriptomic framework for *V. fimicola* by generating RNA sequencing data across key stages of sporocarp formation. Resulting sequence data will be processed using established bioinformatic pipelines for transcriptome assembly, annotation, and differential gene expression analyses. The resulting transcriptomic dataset will provide a foundation for identifying candidate genes and regulatory pathways associated with the transition from trophic cells to mature sporocarps.

015: MCGEE, WILLIE

Major: Horticulture - Bachelor of Science

University: EMCC

Faculty Research Mentor: Raju Bheemnahalli, Plant and Soil Sciences

Co-Authors: Willie McGee¹, Lekshmy V Sankarapillai, Seth Givens, Sachin Cooray, Mary Love Tagert, Donna Peterson, Nuwan Wijewardane, Raju Bheemanahalli

Funding: NSF, Project number 327698

Project Category: Biological and Life Sciences

Impact of combined heat and drought stress on seed weight and number in soybean

Changes in the frequency of heat and drought threaten global food security. While the independent effects of drought and extreme heat on crops are well-documented, their combined occurrence creates a distinct, more damaging impact. However, their combined effects on seed yield components and quality remain poorly understood. We hypothesized that combined heat and drought stress would impose greater damage than either stress alone. To test this hypothesis, Soybean genotypes DS25-1, DT97-4290, and Williams 82 were exposed from full bloom (R2) through seed development to control conditions (CNT; 32°C, full irrigation), heat stress (HS; 38°C, full irrigation), drought stress (DS; 32°C, 40% irrigation), or combined stress (HS+DS; 38°C, 40% irrigation) in a split-plot design. Plants were harvested at physiological maturity to assess yield components and seed traits. Total pod number decreased by only 4.1% under HS but by 25.9% under DS and 36.7% under HS+DS. Under DS, filled and unfilled pod numbers declined by 25% and 37%, respectively. Total pod weight decreased progressively by 9.9% under HS, 32.6% under DS, and 57.2% under HS+DS. Stress-induced changes in seed size distribution are being quantified. Overall, combined heat and drought caused substantially greater reproductive losses than either stress alone.

016: MOBLEY, PORTIA

Major: Biological Sciences - Bachelor of Science

Faculty Research Mentor: Nathan Wisnoski, Biological Sciences

Co-Authors: Nathan Wisnoski

Funding: Shackouls Honors College Research Fellowship

Project Category: Biological and Life Sciences

Seeds of Life Seen in Interstellar Metapopulations

The origins of life on Earth have been one of the greatest questions of humankind. To better understand this question, one can look to life in space. This is the basis of my research. I hope to connect the study of life in space with the field of ecology, which has investigated the processes that regulate life on Earth. However, ecology has yet to be combined independently with the search into how life may have persisted in space. From the field of astrobiology, panspermia theory states that life exists throughout the universe and travels on meteoroids, asteroids, comets, and space dust. From ecology, metapopulation theory explains how a group of spatially separated populations of the same species interacts through migration. I am uniting these fields, viewing astronomical material as habitat patches, to investigate the parameters that could support a unit of life in space through an ecological lens. An expected outcome of this research is to discover theoretical parameters that would allow a unit of life to survive in space, drawing connections between astrobiology and ecology that lead to a greater understanding of the origins of life. To test the given parameters, I am using stochastic simulation models to explore three scenarios of a solar system. In the first simulation, sources of life will only come from asteroids. These asteroids have the chance to hit the planets if they are within a certain radius, colonize the planet, go extinct, or be further dispersed throughout the solar system.

Subsequent simulations will explore how patterns change with different numbers of planets or different spacing between planets. We will then examine under which conditions life persisted in the galaxy.

017: NGUYEN, OANH

Major: Chemistry - Bachelor of Science

University: Auburn University at Montgomery

Faculty Research Mentor: Virginia Montiel-Palma, Chemistry

Co-Authors: Gabriela Sanchez-Lecuona and Virginia Montiel-Palma

Funding: NSF REU: NSF-funded REU-INFEWS: Food-Energy- Water Security

Project Category: Biological and Life Sciences

Selective Hydrogenation of N-Heteroarenes by Heterobimetallic Ruthenium Catalysts

Nitrogen oxide emissions from the combustion of fossil fuels containing nitrogen compounds contribute to air pollution, acid rain, ecosystem degradation, and respiratory diseases such as asthma. Industry relies on hydrodenitrogenation (HDN) to remove nitrogen-containing compounds from petroleum feedstocks using hydrogen over heterogeneous noble-metal catalysts. The severe operating conditions and dependence on precious metals have prompted efforts to develop homogeneous catalytic systems that operate under milder conditions. Selective hydrogenation of N-heteroarenes also provides an efficient route to valuable partially reduced scaffolds used in pharmaceuticals and biologically active molecules. In this work, we report a series of ruthenium(II) arene complexes bearing a carbazolyl ligand cooperatively bound to group 13 metal fragments (Al, Ga), designed to act as catalysts for the hydrogenation of N-heteroarenes. Using ammonia borane ($\text{NH}_3\cdot\text{BH}_3$) as a hydrogen source, we evaluated the catalytic activity of ruthenium complexes in the model hydrogenation of quinoline to 1,2,3,4-tetrahydroquinoline (THQ). Reaction parameters were systematically varied to optimize conversion and selectivity. Among the complexes screened, the zwitterionic Ru-Al tert-butyl carbazolyl complex demonstrated the highest selectivity, producing tetrahydroquinoline (THQ) in 95% yield under mild conditions with low catalyst loading, while minimizing over-reduction and formation of undesired side products. These results highlight the potential of heterobimetallic Ru/group 13 systems as tunable, low-loading, base-metal-friendly platforms for the selective dearomative hydrogenation of N-heterocycles relevant to fuel upgrading and pharmaceutical building-block synthesis.

018: OUREN, MO

Major: Forestry - Bachelor of Science

University: Cal Poly Humboldt

Faculty Research Mentor: Courtney Siegert, Forestry

Co-Authors: Courtney Siegert

Funding: NSF REU: Forestry REU

Project Category: Biological and Life Sciences

Comparison of Dissolved Organic Carbon Bioavailability and Concentration in Forested Ecosystems

Forests deliver high yields of dissolved organic carbon (DOC) into aquatic ecosystems, where DOC either enters the carbon cycle by way of microbial uptake or is discharged into the ocean unaltered depending on its susceptibility to microbial degradation. This study seeks to compare the bioavailability of DOC from forest-derived sources (sample types) and between forest cover types by measuring the concentration and aromaticity of two DOC size classes. Previous research into DOC bioavailability and concentrations have not compared between sample types nor forest types. Sample types were chosen as stream water and leachate from foliage, litter, and soil samples across the pine dominant, hardwood dominant, and forested isolated wetlands in two sites in the Southeastern U.S. Site, stand type, sample type, and filter size were analyzed for their effect on DOC concentrations and aromaticity. The preliminary findings show substantial variation among sample types. Mean DOC concentrations were measured at 19.48 ± 1.60 mg/L for litter, 14.18 ± 4.81 mg/L for soil, 123.33 ± 16.50 mg/L for foliage, and 12.62 ± 1.78 mg/L for stream water. Mean specific ultraviolet absorbance (SUVA) values were 4.37 ± 0.15 L/mg-M for litter, 2.04 ± 0.24 L/mg-M for soil, 1.84 ± 0.20 L/mg-M for foliage, and 7.75 ± 0.28 L/mg-M for stream water, with higher readings indicating lower bioavailability. Further statistical analyses, including analysis of variance (ANOVA), Tukey's post hoc tests, and mixed-effects models, will be conducted to determine the significance of these differences. The results of this study can help

elucidate the implications of forest management for aquatic food webs and carbon dioxide emissions through comparison of DOC inputs.

019: RAY, AYL

Major: Biological Sciences - Bachelor of Science

University: Syracuse University

Faculty Research Mentor: Kristy McAndrew, Department of Forestry

Funding: NSF REU: Summer 2026 Ecology and Management for Resilient and Adapted Forests (Forestry) REU

Project Category: Biological and Life Sciences

Assessing the attractiveness of saprotrophic mushroom mycelia to western honeybees.

The western honeybee, *Apis mellifera* L. (Hymenoptera: Apidae), is essential to crop production and global food security. Despite their importance, western honeybees face significant health threats to colony productivity and viability. One of the most significant threats includes the infestation of the parasitic mite *Varroa destructor* and its associated viruses, including deformed wing virus (DWV), Lake Sinai virus (LSV), and *Varroa destructor* virus-1 (VDV1). Recent studies have demonstrated reduced levels of DWV and LSV resulting from the consumption of saprotrophic polypore mushroom mycelia. However, it remains unknown if honeybees are attracted to saprotrophic mushroom mycelia or actively forage for it as a resource. Here, we build on our preliminary work which found honeybees were statistically more likely to choose petri dishes with fungal mycelium compared to sterile plates ($p < 0.0001$ for three fungal species tested). We assessed western honeybee attraction to saprotrophic mushroom mycelia, including *Pleurotus ostreatus*, *Lentinula edodes*, *Hericium erinaceus*, and *Ganoderma lucidum*, by i) conducting traditional choice assays using a y-tube olfactometer in a laboratory setting, and ii) conducting observational field choice methods within apiaries in Starkville, MS. This study examines the relationship between western honeybee and saprotrophic mushroom mycelia, specifically, to understand *A. mellifera* preference when presented between non-fungal (sterile PDA) and fungal food sources, and potential preferences between fungal food sources. Improving our understanding of this relationship could support fungal-based health supplements and new apiary methods, including the integration of mushroom logs to both benefit colony health and provide valuable secondary products.

020: SHEFFIELD, MORGAN

Major: Biochemistry - Bachelor of Science

Faculty Research Mentor: Galen Collins, Department of Biochemistry

Co-Authors: Galen Collins

Project Category: Biological and Life Sciences

Do Yeast Throw Out Their Trash? Testing if loss of Ddi1 increases protein secretion by reducing protein degradation.

Ddi1 is a ubiquitin-dependent protease found in the yeast *Saccharomyces cerevisiae*. It is a homolog of mammalian Ddi2, known to mediate Endoplasmic Reticulum-Associated Degradation (ERAD). Ddi1 has not been implicated as a contributor to ERAD. Due to an observed response of yeast being unable to remove misfolded proteins from the ER we hypothesize the loss of Ddi1 increases protein secretion. Our work determines whether Ddi1 plays a role in ERAD measuring the effects of deleting Ddi1 in yeast on protein secretion, degradation, ER stress, and cell viability. Folding of secreted proteins occurs in the ER, it is important to study the factors that influence ERAD, as cancer cells are often undetected due to the clearance of misfolded proteins. If Ddi1 can be inhibited in the ER to signal apoptosis, it may have therapeutic relevance. Better understanding how Ddi1 affects ERAD will allow us to comprehend how Ddi2 plays a similar role in humans. To determine the effects of Ddi1 in ERAD, protein secretion levels in the ER will be measured comparing the effects of deleting *dsk2* and *rad23*, which are known proteases in ERAD, along with Ddi1. The effect of Ddi1 on degradation, is tested by adding cycloheximide to inhibit protein synthesis and measure levels of CPY*, a misfolded protein found in the ER lumen. Tunicamycin increases CPY* secretion. Strains with and without Ddi1 will be compared on Tunicamycin plates, to determine if Ddi1 is important for stress tolerance. Addition to increasing protein secretion, I expect Ddi1 to help yeast tolerate ER stress and possibly increase cell viability under such conditions. There may be nuances in the function of Ddi1 that lead to results differing from expectations; these results will increase understanding of Ddi1's role in ERAD.

021: SINGLETON, JAYLA

Major: Biochemistry - Bachelor of Science

University: Eastern Illinois University

Faculty Research Mentor: Erika Womack Peoples, Biochemistry, Nutrition, and Health Promotion

Co-Authors: Chiquita Price, Erika D. Womack Peoples

Funding: NSF REU: Chemistry, NSF REU Grant 2447730

Project Category: Biological and Life Sciences

Revenge of the Corn: Characterization of Volatile Metabolites in Maize in Response to Fall Armyworm Leaf Feeding

Fall armyworm (*Spodoptera frugiperda*) (FAW) is an invasive pest that attacks maize (*Zea mays*) crops during its larval stage, damaging a globally established food source which supports innumerable populations. Climbing pesticide resistance within FAW populations has incentivized alternative pest control methods through developing pest-resistant genotypes. Plant metabolic byproducts, particularly secondary metabolites, play an important role in crop defense against external stressors such as herbivory, pathogen attack, and abiotic stress. While certain profiles of *Z. mays* metabolomic defense against herbivory have been compiled, temporal viewpoints analyzing the progression of volatile compound composition over time remain understudied. Solid-phase microextraction (SPME) fibers and Smart SPME Arrows were used to collect volatile organic compounds (VOCs) produced by *Z. mays* in response to FAW herbivory within a pest-resistant line (Mp706) after allotted feeding times. Volatiles were analyzed by GC/MS and compared to verified compounds on the NIST 2023 database. Metabolic pathways associated with heightened volatile compound production were highlighted. Additional detection of metabolites within infested leaves and FAW frass via untargeted LC/MS analysis expanded the understanding of metabolites responsible for pest resistance within maize. Analyzing the effectiveness of pest-resistant lines against herbivory will support the development of novel, more resistant lines with enhanced pest control abilities and remove global reliance on pesticides specifically for maize growth.

022: SMITH, MATTHEW

Major: Biochemistry - Bachelor of Science

University: Southeast Missouri State University

Faculty Research Mentor: Nicholas Fitzkee, Chemistry

Co-Authors: Gabriel Alcantara, Nicholas Fitzkee

Funding: NSF REU: Funded by NSF REU grant 2447730

Project Category: Biological and Life Sciences

Investigating optimal conditions for C1q and C1qA expression and purification in *E. coli*

Complement proteins work as labelling agents for the innate immune system. Complement component protein 1q (C1q) is a member of the C1 protein complex and is responsible for identifying threats and foreign material. One area of interest is understanding optimal conditions for recombinant expression of C1q and C1qA in *E. coli*. Recombinant expression would enable more advanced mechanistic studies of how this protein identifies potential threats. Relevant expression conditions include parameters such as cell growth time, induction time, and growth media. These conditions influence whether C1q forms insoluble inclusion bodies during expression. In addition to testing growth conditions, we also sought to resolubilize and refold C1q. We developed a successful method that involves unfolding the protein. During this investigation, we explored both chemical and procedural conditions, such as introducing additives that increase protein solubility and on-column refolding. Work is ongoing to develop reliable methods for generating correctly folded C1q and C1qA both from inclusion bodies and in soluble form.

023: SNODGRASS, EMILY

Major: Biochemistry - Bachelor of Science

Faculty Research Mentor: Galen Collins, Biochemistry

Co-Authors: Galen Collins

Funding: College of Agriculture and Life Sciences URSP

Project Category: Biological and Life Sciences

Using Yeast to Study How Human Proteases Control Vesicle Trafficking

Protein trafficking is essential for maintaining cellular function. For example, proteins needing to be transported to the plasma membrane require intracellular vesicles whose fusion with the cell membrane is mediated by SNARE proteins, such as Sso1 within *S. cerevisiae*. The protease Ddi1 negatively regulates exocytosis by binding to SNARE proteins like Sso1. Our aim is to identify specific binding regions between Ddi1 and Sso1 that are relevant to this interaction. We are using the model organism *S. cerevisiae* for this investigation. Mapping interactions between these proteins will provide insight into the protein quality-control processes associated with secretion pathways. These findings should also apply to higher eukaryotes; much remains to be discovered about Ddi2, the human ortholog of Ddi1. Acquiring more knowledge of its role through examining Ddi1 can contribute to knowledge of many diseases involving protein degradation. Identifying these conserved regions in proteins focuses on modeling protein structures in AlphaFold3/PDBePISA programs; this has enabled an interface analysis of sites in a variety of proteins within the Ddi1 and SNARE protein families. Preliminary information has revealed highly conserved amino acids that mediate binding, opening the door to testing through experimental validation. Mutations will be created to test the effect of altering structure on secretion/trafficking. Specifically, invertase secretion assays (functional, folded invertase) and antibodies against Suc1 (total invertase) will be used. We expect that although functional protein secretion does not significantly increase, total protein will. Hopefully, new interactions between Ddi1/Sso1 can be identified, indicating a valuable role for them in SNARE-mediated trafficking.

024: TAYLOR, JACK

Major: Horticulture - Bachelor of Science

University: Farmingdale State College

Faculty Research Mentor: Christine Fortuin, Forestry

Co-Authors: Mary McTeague, Christine C. Fortuin

Funding: NSF REU: Forestry REU

Project Category: Biological and Life Sciences

Non-bee Pollinator Communities Associated with White Tail Deer Forage Plants.

It is well known that pollinators have beneficial, and in many cases necessary, relationships with herbaceous plants, an important food source for white tail deer. Having an appropriate forage base for white tail deer nutrition, specifically in forests managed for wildlife, is important for hunters and landowners, as well as for wildlife management goals and conservation purposes. To deepen this understanding of deer forage system ecology we studied the pollinators of known deer forage plants. Bees (Hymenoptera: Apoidea) are considered one of the most significant pollinator groups, but this study examines non - bee (most commonly Diptera, Coleoptera, Hymenoptera, Lepidoptera) pollinator relationships, which are often overlooked. Study sites include two areas managed for wildlife, Noxubee Wildlife Refuge and Longview Forest. At each site, six unburned 30 meter plots were selected, and within each plot we set up five insect traps and conducted a plant transect survey. Traps consist of two Blue-Vane traps (clear and yellow) and three pan traps (yellow, white, and blue). These were aimed to attract the appropriate pollinator species in order to identify the insect community composition of the deer forage system. Traps were left out for a total of two days in May and in June before collection and brought to the lab. Lab procedures include the processing of trap catch through pinning, pointing, and identification to insect family. We hypothesize outside of Apoidea, there should be a strong presence of pollinators within the orders Coleoptera (Mordellidae, Curculionidae, Buprestidae) and Diptera (Syrphidae, Tachinidae). Preliminary findings show a significant number of these pollinators, as well as broad diversity within insect orders.

025: ULDRICH, ELLIANNA

Major: Biological Sciences - Bachelor of Science

Faculty Research Mentor: Russell Carr, Department of Comparative Biomedical Sciences

Co-Authors: Kendall N. McKinnon, Hayden M. Anderson, Shirley X. Guo-Ross, Russell L. Carr

Funding: Shackouls Honors College Research Fellowship

Project Category: Biological and Life Sciences

Alteration of Hepatic Lipid Homeostasis following Exposure to Organophosphate Pesticide Metabolite Chlorpyrifos-oxon

Chlorpyrifos (CPF) is one of the most commonly used organophosphorus (OP) pesticides. Once it is absorbed into the body, it is metabolized in the liver to form chlorpyrifos-oxon which is a known inhibitor of acetylcholinesterase (AChE). Inhibition of this enzyme's activity causes an overstimulation of the cholinergic system via the accumulation of the neurotransmitter acetylcholine. Additionally, CPO inhibits enzymes present in the liver such as carboxylesterase (CES) and fatty acid amide hydrolase (FAAH). These are not considered target enzymes of CPO. CES is a serine hydrolase enzyme and plays a key role in lipid catabolism and mobilization throughout the body. FAAH is a key regulator of lipogenesis and fatty acid oxidation via the breakdown of fatty acid amides in the endocannabinoid system. The inhibition of these two enzymes has the potential to cause lipid imbalances resulting in metabolic disruption. The purpose of this project is to determine a dose-response relationship between CPO and the inhibition of CES and FAAH in the liver of juvenile rats. To investigate this, rat pups at 21-days-old were subcutaneously administered with either vehicle or increasing dosages of CPO (0.5, 0.75, 1.0, 1.25, 1.5, 1.75, 2.0, 2.5, 3.0, 3.5, and 4.0 mg/kg). Three hours after treatment, liver and serum were collected and stored at -80°C. Liver tissues were later homogenized and centrifuged to make liver supernatant to measure activity of CES and FAAH. At the lower dosages, no inhibition of FAAH or CES was seen. As dosages increased, the level of inhibition present increased for both enzymes. However, greater inhibition was observed with FAAH as compared to CES. This suggests that processes mediated by FAAH, but not those mediated by CES, could be disrupted at low dosages of CPO.

026: UPADHYAY, KRITIKA

Major: Computer Science - Bachelor of Science

University: University of Southern Mississippi

Faculty Research Mentor: Mary Love Tagert, Department of Agriculture and Biological Sciences

Funding: College of Agriculture and Life Sciences URSP

Project Category: Biological and Life Sciences

Hyperspectral Prediction of Plant Gas-Exchange Responses Using Machine Learning

Hyperspectral imaging measures how plant leaves reflect light across wavelengths, allowing us to assess the health of plants without damaging them. Previous studies have shown that spectral data combined with machine learning can be used to detect plant stress and estimate physiological and biochemical traits. In the initial phase of this study, hyperspectral reflectance data were used to predict plant pigment measurements. However, preliminary analysis showed weak correlations between pigment concentration and spectral reflectance. Therefore, the study was expanded to investigate whether hyperspectral data can be used to predict gas-exchange traits, which provide direct information about plant physiological activity and stress response. Gas-exchange measurements, including photosynthetic rate, stomatal conductance, transpiration, and intercellular CO₂, will be evaluated as prediction targets. Partial least squares regression will be used as a baseline model and compared with nonlinear machine-learning approaches such as random forest, support vector regression, gradient boosting, and artificial neural networks. Model performance will be assessed using cross-validation, coefficient of determination, root mean squared error, and mean absolute error.

027: YUSUF, MAHMOUD

Major: General Science - Bachelor of Science

University: Florida State University

Faculty Research Mentor: Joseph Frascella, VP Research (RESEARCH) 219000

Co-Authors: Joseph Frascella

Project Category: Biological and Life Sciences

Multimodal Prediction of Shunt Responsiveness in Idiopathic Normal Pressure Hydrocephalus: A Narrative Review

Idiopathic normal pressure hydrocephalus (iNPH) is a potentially treatable neurologic syndrome of older adults, yet predicting which patients will improve after cerebrospinal fluid (CSF) shunting remains difficult because its symptoms and imaging findings overlap with neurodegenerative, vascular, musculoskeletal, and urologic disorders. This narrative review synthesized evidence on clinical, radiologic, CSF drainage, physiologic, biomarker, and multimodal predictors of shunt responsiveness in iNPH. PubMed, Google Scholar, major guidelines, systematic reviews, meta-analyses, and primary cohort studies were reviewed, with emphasis on adult iNPH, postoperative improvement, and preoperative

predictors of response. Across the literature, gait-dominant presentation and shorter symptom duration appeared clinically relevant, while chronological age alone did not appear to justify exclusion from shunt consideration. Radiologic markers, including disproportionately enlarged subarachnoid-space hydrocephalus, callosal angle, and periventricular white matter changes, supported diagnostic plausibility but were limited as stand-alone predictors of postoperative response. Positive CSF tap testing and increased resistance to CSF outflow supported patient selection, but low negative predictive value limited their usefulness as exclusionary tests. Tau-related CSF biomarkers may help identify neurodegenerative burden associated with non-response, although current evidence remains insufficient for independent surgical decision-making. Early multimodal prediction models showed conceptual promise but limited predictive performance. Overall, iNPH patient selection should be framed as a multimodal prediction problem rather than a single-test diagnostic problem. Future research should develop standardized models integrating clinical, imaging, physiologic, biomarker, and outcome-risk data to support individualized surgical decision-making.

BUSINESS AND ECONOMICS

028: SHACKELFORD, TAYLOR

Major: Management - Bachelor of Business Adm

Faculty Research Mentor: Michele Craven, Management and Information Systems

Co-Authors: Michele Craven, Alyssa Bevacqua, Maria Bracamonte

Funding: None

Project Category: Business and Economics

Behavioral Inertia and Organizational Change: The Role of Founder Psychology

In founder-led small businesses, the owner's psychological disposition shapes organizational health and adaptability. This study uses a qualitative multi-case analysis of six hospitality ventures—a nightclub, a sports bar, a themed bar, and three dive bars—to examine how founder personality traits influence organizational decline and recovery. Comparing a partnership, two sole proprietorships, and three family-owned firms, the study identifies the founder as the central force shaping the business's informal operational framework. The findings reveal that a pervasive laissez-faire leadership style, rooted in apathy and defeatism, drove operational stagnation across the four laissez-faire cases. These traits created behavioral inertia that prevented owners from addressing financial and reputational challenges. During the intervention phase, however, a critical divergence emerged: five owners, including two with autocratic leadership styles, were receptive to external guidance, while the final autocratic owner resisted and negotiated reform. These findings suggest that leadership orientation influences an organization's capacity to adapt under pressure and that organizational outcomes ultimately depend on both leadership style and environmental influence. Ultimately, organizational decline in small bars is driven less by market conditions than by the founder's psychological limitations. Intervention shifts founders from defensive ego-protection to operational accountability. Organizational change depends on the founder's willingness to align leadership with business needs, demonstrating that in small-scale enterprises, the person and the process are inextricably linked.

EDUCATION

029: HAYES, CHARLES

Major: Secondary Education - Bachelor of Science

Faculty Research Mentor: Qiana Cutts, College of Education

Funding: None

Project Category: Education

The Importance of a Financial Literacy Requirement for all Mississippi High School Graduates

Financial literacy is a vital skill for achieving financial independence and long-term stability; yet many high school students graduate without a basic understanding of personal finance. To address this gap, in 2026, Mississippi lawmakers proposed House Bill 1710 and Senate Bill 2294, requiring financial literacy instruction as a high school graduation requirement in public schools. Supporters argue that such requirements could improve graduates' earning potential, reduce debt, strengthen financial decision-making, and help break cycles of poverty. They also contend that schools have a responsibility to equip students with practical life skills that promote overall well-being. Although both

bills received broad public and bipartisan support, concerns about curriculum design, teacher preparation, and education policy have generated debate over implementation. Nevertheless, advocates maintain that expanding financial literacy education would provide significant long-term benefits for students and Mississippi's future workforce and economy.

ENGINEERING

030: ANDERSON, AUBREY

Major: Computer Science - Bachelor of Science

University: Centre College

Faculty Research Mentor: Maxwell Young, Computer Sci. and Eng.;

Co-Authors: Umesh Biswas, Katie Huang, Maxwell Young

Funding: NSF REU: Cybersecurity

Project Category: Engineering

Contention Resolution with Volume-Limited Jamming

We study contention resolution on a multiple-access channel where packets may transmit at different volume levels. Higher-volume transmissions can overpower lower-volume transmissions, but using a higher volume incurs cost proportional to the chosen volume. The channel is further complicated by an adaptive jammer that can inject noise at bounded volume levels below the maximum packet volume. Packets do not know the number n of active contenders and receive only coarse channel feedback: empty slot, successful transmission, or collision/noise. We develop algorithms for resolving contention quickly while keeping packet cost asymptotically comparable to the jammer's cost. Our preliminary analysis suggests a family of latency-cost tradeoffs, ranging from polylogarithmic-latency algorithms with $\tilde{O}(n^{1+\epsilon})$ packet cost, for small constant $\epsilon > 0$, to near-linear-time algorithms with packet cost linear up to polylogarithmic or mildly super-polylogarithmic factors.

031: BHATTARAI, PRASHANT

Major: Mechanical Engineering - Bachelor of Science

Faculty Research Mentor: Daniel Carruth, CAV

Co-Authors: Dr. Chris Goodin

Funding: Shackouls Honors College Research Fellowship

Project Category: Engineering

Hierarchical Multi-Agent Navigation: UAV-Assisted Map Recovery for Ground Vehicles

Autonomous ground vehicles navigating unstructured, off-road environments, such as those encountered during search-and-rescue missions, must safely steer through complex surroundings using ground-level sensors. However, when these vehicles encounter dense brushes, tall grass, or maze-like terrain, their sensors cannot see far enough. This line-of-sight occlusion causes their internal maps to fail, resulting in the vehicle becoming permanently stuck. This research focuses on developing a "call-for-help" protocol that allows a ground vehicle to automatically deploy a companion aerial drone when it loses its way. The study uses MAVS for building virtual environments and the Robotics Operating System (ROS2) for programming the vehicle's software logic. Instead of relying on a constantly flying drone, which quickly drains batteries and overloads communication networks, this project implements a targeted, on-demand approach. The ground vehicle completely halts and requests an overhead scan when its path planner is unable to find an open path. The drone flies overhead to generate a clear, top-down spatial map that is transmitted and seamlessly merged with the ground vehicle's local map. This study investigates whether this map-merging approach allows the ground vehicle to calculate a safe exit route and successfully resume navigation. Simulated environments featuring dynamic obstacles that block the vehicle's visible paths are used to rigorously evaluate the system's behavior. Performance metrics include the overall success rate of the vehicle finding an alternative route, escaping the obstacle, and executing necessary maneuvers in narrow spaces. To validate these findings, the simulation framework will be transitioned to physical hardware testing using RC cars. The results of this research will help determine whether on-demand aerial support can improve the robustness of autonomous ground vehicle operations in complex off-road environments.

032: BLOSS, CHARLES

Major: Industrial Engineering - Bachelor of Science

University: Louisiana State University

Faculty Research Mentor: Seunghan Lee, Industrial & Systems Engineering

Co-Authors: Seunghan Lee, Jason T. Street, Christine Fortuin, Kevin Ragon, Xinchao Liu, Haifeng Wang, Mohammad Marufuzzaman

Funding: USDA REU

Project Category: Engineering

Assessing Forest Health in the Southeastern United States Using Machine Learning

Forests of the southeastern United States play a vital role in biodiversity, carbon storage, and ecosystem stability. However, climate change, deforestation, and other environmental pressures have increased the need for efficient methods to assess forest health. This study evaluates forest conditions using satellite imagery, employing two major indices: the Normalized Difference Vegetation Index (NDVI) and the Soil-Adjusted Vegetation Index (SAVI).

Vegetation index data derived from NASA satellite imagery were analyzed and used as input for a machine learning model that classified forested areas as healthy, stressed, or degraded. A comparative analysis was also conducted across the southeastern United States in East Texas, Louisiana, Mississippi, Alabama, & Florida to identify the state with the healthiest forest conditions, along with a state-level analysis to evaluate forest health within each state. The state-level comparison also revealed differences in the proportions of healthy, stressed, and degraded forest areas among the analyzed states, while the detailed spatial analysis identified localized areas of vegetation stress within individual states. The analysis found that a substantial portion of the study area was classified as stressed, primarily based on NDVI values, indicating widespread vegetation stress across the region. These results demonstrate the effectiveness of combining remote sensing with machine learning to rapidly assess forest health and identify areas requiring further investigation. Future research should examine the characteristics of forests classified as healthy to better understand the factors that promote resilience and inform conservation and restoration efforts in stressed and degraded ecosystems.

033: BRAIMAH, EMMANUEL

Major: Aerospace Engineering - Bachelor of Science

Faculty Research Mentor: Vivek Khare, Department of Aerospace Engineering;

Co-Authors: Will Doughty

Funding: None

Project Category: Engineering

EXTENDING THE PHYSICS INFORMED GEOMETRY AWARE NEURAL OPERATOR TO STRUCTURAL RESPONSE PREDICTION OF CFRP COMPOSITE CANTILEVER BEAMS

Advanced space composite structures require repeated finite element analysis and physical testing across combinations of geometry, material properties, and loading, making early design studies slow and expensive. Neural Operators address the case-by-case limitations of traditional machine learning by learning mappings between input and output functions, enabling generalization across parameters and domains. This work investigates whether the Physics-Informed Geometry-Aware Neural Operator (PI-GANO) can predict the structural response of static 2D cantilever beam representative of a simplified quasi-isotropic CFRP member under plane stress and small deformation. The model predicts full-field displacements from geometry, material, and load inputs, then recovers stresses from the learned displacement field. Abaqus simulations varied beam length, height, elastic properties, and end-load magnitude. PI-GANO was reformulated to encode global parameters and geometry, while ablation studies evaluated parameter encoding, nondimensionalization, node awareness, hard enforcement of clamped-edge boundary conditions, and purely data-driven training. Results showed that nondimensionalization was necessary for stable training and that parameter encoding strongly affected mechanics-sensitive learning. The best physics-informed model produced accurate displacement predictions and more reliable stress recovery than the data-driven baseline. Although the data-only model fit displacement well, its stress predictions were less accurate, indicating that local displacement errors were amplified through differentiation. External evaluations showed reliable generalization within the training parameter range.

034: BRITT, ELLA

Major: Biosystems Engineering - Bachelor of Science

Faculty Research Mentor: Mary Love Tagert, Agricultural and Biological Engineering;

Co-Authors: Mary Love Tagert, Sam Theobald

Funding: Mississippi Soybean Promotion Board

Project Category: Engineering

Evaluating Variable Rate Irrigation on a Soybean Production Field

2026 Undergraduate Research Symposium Abstract Ella Britt, Sam Theobald, Mary Love Tagert The Black Prairie region of Northeastern Mississippi has limited access to groundwater due to drilling depths, with only 37% of the region's annual precipitation occurring during the growing season. With these limitations, growers in Northeast Mississippi have a finite amount of water available to irrigate their crops. The primary solution to water management in this region is to create on farm water storage systems (OFWS). These retention ponds have been built throughout the Black Prairie region in recent years, capturing and storing runoff and precipitation. The retained water can then be used to irrigate during the growing season when periods of drought occur. This study quantifies the differences in soil moisture when sector control variable rate irrigation (VRI) is implemented on a production field in Noxubee County, Mississippi. Two irrigation treatments (full application rate and 20% reduced rate) were applied to two different management zones in the same field – a dry irrigation zone and a wet irrigation zone. Both zones were split into six pie-shaped sectors with three replicates of both irrigation treatments in each zone, resulting in a total of 12 sectors. Granular matrix sensors were placed in the centroid of the outermost span of each sector. These sensors measured soil water tension in the rooting zone at depths of 12 and 24 inches throughout the growing season. Soil water tension is being analyzed with irrigation and precipitation data to determine the potential water-saving benefits of VRI. Future work will include analysis of soybean yield across the different irrigation treatments and management zones.

035: BUCHANAN, ANDREW

Major: Mechanical Engineering - Bachelor of Science

Faculty Research Mentor: Qingqing Liu, Mechanical Engineering

Co-Authors: Qingqing Liu

Funding: Mechanical Engineering Department

Project Category: Engineering

CFD Assessment of Heat Transfer and Frictional Pressure Loss Correlations for Molten Salt Reactors with Non-Condensable Gases

Non-condensable gas (NCG) bubbles generated by fission products, radiolysis, helium sparging, and external contamination can significantly affect the thermal-hydraulic performance of molten salt reactors (MSRs). Although modern MSR system analysis codes incorporate gas transport models, many of their heat transfer and pressure-loss closure relationships are derived from conventional water-based databases and have received limited validation for molten salt-gas systems. This study evaluates the applicability of existing two-phase heat transfer and frictional pressure-loss correlations for bubbly molten salt flows using computational fluid dynamics (CFD). A two-dimensional axisymmetric model of turbulent FLiNaK-helium flow was developed in ANSYS Fluent using the mixture model coupled with the SST turbulence model. The model was validated against experimental air-water correlations, and the validated model was then used to benchmark seven heat transfer correlations and four frictional pressure-loss correlations under representative MSR conditions. The results show that increasing void fraction at constant velocity reduces the convective heat transfer coefficient because of decreased effective thermal conductivity, volumetric heat capacity, and mixture Reynolds number, whereas increasing flow velocity enhances heat transfer through stronger turbulent mixing. Frictional pressure loss decreases with increasing void fraction at constant velocity owing to reductions in mixture density and viscosity but increases with Reynolds number. Among the evaluated models, the Aggour correlations provided the best agreement for heat transfer, while the Müller-Steinhagen and Heck correlation most accurately predicted frictional pressure loss.

036: BUSCHING, LUTHER

Major: Mechanical Engineering - Bachelor of Science

University: University of Nebraska-Lincoln

Faculty Research Mentor: Jacob Moore, Institute for Systems Engineering Research

Co-Authors: Jacob Moore, Eric Collins

Funding: NSF REU: Award # 2348712 Research Experience for Undergraduates in Computational Methods with Applications in Material Science

Project Category: Engineering

Toward an Efficient Simulation Tool for Predicting Residual Stress in Metal Additively Manufactured Parts

Metal additive manufacturing has experienced rapid growth across a variety of industries due to its ability to fabricate parts with complex, customizable geometries in a fraction of the time and material required by conventional processes. However, because metal is selectively melted and resolidified in a layer-wise deposition process, the cyclical heating and cooling induces expansion and contraction that can accumulate as residual stress within the part's microstructure. This buildup of residual stress can lead to print failures or degraded part performance, yet the mechanisms governing residual stress formation during printing remain poorly understood. Existing simulation techniques for predicting residual stress in additively manufactured parts are either inaccurate or too computationally expensive for practical use. This project advances a new thermal solver for metal additive manufacturing simulation, built within Fierro — a computational mechanics code developed at Los Alamos National Laboratory (LANL) that leverages the MATAR library and the Kokkos framework to run efficiently across CPU and GPU architectures. Key advancements include a more flexible heat source model capable of representing both symmetric and directionally dependent (scan-direction-oriented) energy distributions. The solver was also extended to support multilayer simulations, with melt-region temperatures output for process visualization. Together, these advancements represent significant progress toward a high-fidelity, computationally efficient thermal solver capable of studying the relationship between the printing process and residual stress accumulation in metal additively manufactured parts.

037: CHUNG, KATIE

Major: Mechanical Engineering - Bachelor of Science

Faculty Research Mentor: Jian Zhao, Mechanical Engineering;

Co-Authors: Jian Zhao, Hao-Wei Huang

Funding: None

Project Category: Engineering

Assessment of Thermoelectric Waste Heat Recovery for High-Performance Computing Systems

The rapid growth of artificial intelligence and digital services has increased the energy demands of data centers, resulting in large quantities of waste heat. High-performance computing (HPC) facilities are expected to generate up to 2 quadrillion Btu of waste heat annually by 2030, contributing to energy inefficiency and increasing pressure on electrical infrastructure. Recovering this energy could improve the sustainability of modern computing systems. This research evaluates thermoelectric generators (TEGs) as a method for recovering waste heat from data centers. TEGs generate electricity through the Seebeck effect by converting temperature gradients into electrical voltage. An experimental platform was developed to simulate HPC conditions using a thermal bath (25–50 °C), thermoelectric modules, aluminum fins, and adjustable air-cooling systems. The platform allows systematic investigation of the effects of operating temperature and cooling conditions on device performance. Experimental results showed that voltage output increased with both hot-side temperature and fan power. Generated voltage rose from approximately 40 mV at 25 °C to approximately 860 mV at 50 °C. These results demonstrate the feasibility of using thermoelectric generators to capture waste heat from data centers and convert it into usable electrical energy, supporting future efforts to improve energy efficiency in computing infrastructure.

038: DA SILVA, CAMILA

Major: Computer Science - Bachelor of Science

Faculty Research Mentor: David Van den Heever, Ag & Bio Engineering

Funding: None

Project Category: Engineering

Low-Rank Adaptation for Personalized Motor Imagery EEG Decoding

Electroencephalography (EEG) is a highly efficient, non-invasive technique that uses electrodes placed on the scalp to record electrical brain activity. EEG has become one of the leading technologies powering brain-computer interfaces (BCIs), which leverage powerful machine learning (ML) techniques to decode brain activity, allowing individuals with motor impairments to communicate or interact with external devices. However, EEG decoding faces a fundamental challenge: brain signals exhibit high variability across individuals, meaning that an ML model trained on multiple subjects may perform poorly on a particular subject's data. This has made transfer learning an essential focus in the field, as it allows general, pre-trained models to be adapted to a specific subject or task, improving classification accuracy. Therefore, this study examines the effectiveness of low-rank adaptation (LoRA) for personalizing pre-trained EEG models, specifically within the motor imagery (MI) paradigm, which involves recording an individual's brain activity while they imagine performing specific movements. The Graz dataset A from the 2008 BCI Competition IV was used, which contains EEG recordings of four MI tasks (left hand, right hand, both feet, and tongue) from 9 subjects. The data were bandpass filtered between 8 and 30 Hz to isolate the alpha and beta bands relevant to MI classification. A base convolutional-Transformer model was then trained for each subject using a leave-one-subject-out strategy. To personalize each pre-trained model, LoRA was applied by freezing its original parameters and injecting low-rank matrices ($r=8$, $\alpha=16$) into the feedforward linear layers of the Transformer blocks, using only 50 trials per MI task for adaptation. This approach improved per-subject classification accuracy by an average of 11.2 percentage points, with a maximum improvement of 17.8 points, demonstrating that LoRA is a highly effective mechanism for personalizing MI-EEG decoding models.

039: DOOLEY, JOSEPH

Major: Industrial Engineering - Bachelor of Science

Faculty Research Mentor: Haifeng Wang, Industrial and Systems Engineering

Co-Authors: Dustin Gavins, Amirhossein Eskorouchi, Christine Fortuin, Haifeng Wang

Funding: None

Project Category: Engineering

Comparative Evaluation of Transfer Learning Models for Bark Beetle Gallery Classification

Bark beetles are among the most destructive forest pests in North America, causing widespread tree mortality. Southern working pine forests are especially at risk of bark beetle infestations. Accurate identification of bark beetle galleries is critical for monitoring and addressing infestations. Traditional identification methods rely on expert knowledge and manual examination of gallery patterns, which are time-consuming and subject to human error. This research investigates the feasibility of deep learning for automated bark gallery classification by comparing the performance of five transfer learning convolutional neural networks (CNNs): MobileNetV2, MobileNetV3-Large, DenseNet-121, ResNet-18, and EfficientNet-B0. Each CNN architecture was trained to classify images of bark beetle galleries and pine trees into three categories: Southern Pine Beetle (SPB), Ips Engraver beetle, and a non-gallery control class. The dataset contained 115 unique images, consisting of 36 unique non-gallery images and 79 unique bark galleries. The original images were divided into multiple crops, resulting in 466 total images to address the limited dataset. Data augmentation, five-fold stratified cross-validation, and fine-tuning were employed to improve model generalization. Model performance was evaluated using classification accuracy, precision, recall, F1-score, training time, and inference time. The best-performing model achieved an average classification accuracy of 0.9828 ± 0.0096 with an F1-score of 0.9827 ± 0.0095 , requiring 3165.17 seconds for training and an average inference time of 26.02 ms per image. Based on these results, DenseNet-121 provided the highest accuracy and predictive performance while maintaining practical inference times for bark beetle gallery classification.

040: DREZNICK, MANDY

Major: Industrial Engineering - Bachelor of Science

University: Louisiana State University

Faculty Research Mentor: Jason Street, Department of Sustainable Bioproducts

Co-Authors: Jason Street, Mohammad Marufuzzaman, Tilak Neupane, Mai Viet Tan Tran, Kayla Pigott

Funding: USDA AI2F REEU

Project Category: Engineering

Determining Wood Chip Moisture Content Using Deep Learning Approaches

The moisture content of wood chips determines the amount of energy that can be obtained from them. Higher moisture contents (MC) result in a reduction in the amount of heat that can be generated by reducing the net calorific value. Currently, wood chip MC is measured by oven drying a portion of the wood chip shipment upon arrival. However, this method is time consuming, prone to sampling errors, and renders the tested sample unusable. Therefore, we aimed to develop a deep learning model that can quickly and accurately classify wood chips into wet and dry classes as they travel along a conveyor. The proposed deep learning model combines convolutional neural networks with an adaptive boosting technique to allow five neural networks to evaluate samples and vote to generate a final determination. The adaptive boosting method allows each model to learn from the earlier model's mistakes by adjusting the weights and focusing on missed predictions. This project created a dataset of red oak (*Quercus rubra*) wood chip images and weights at various moisture content levels. The moisture contents were divided into wet and dry categories: dry being 0-16% MC and wet being above 16% MC. RGB images of individual wood chips were taken at different MC percentages. The images will then be used to train the model to classify wood chips into the MC classes. We aim for the final model to have a high accuracy, ideally above 90%, that can be implemented into a handheld device that can be used in an industrial setting as a quick and accurate alternative to current methods.

041: EDWARDS, ESTHER

Major: Chemistry - Bachelor of Science

University: Texas A&M

Faculty Research Mentor: Neeraj Rai, Chemical Engineering

Co-Authors: John Michael Lane

Funding: NSF REU: NSF REU: Computational Methods with applications in Materials Science, award #2348712

Project Category: Engineering

Computational investigations in cyclohexanol conversion in zeolites

The acid-catalyzed conversion of cyclohexanol to cyclohexene is a vital chemical process across the pharmaceutical, polymer, and petrochemical industries. Zeolites are porous catalysts known for their shape and size selectivity, which makes them especially useful for this reaction by preventing the formation of bulkier, undesirable side products. In this work, we computationally explore the reaction mechanism by which cyclohexanol dehydrates at Brønsted acid sites within the zeolite frameworks MFI and FAU. To overcome the high computational cost of Ab Initio Molecular Dynamics (AIMD) while capturing long-timescale dynamics, we trained a Machine Learning Interatomic Potential (MLIP) using data sampled from short AIMD trajectories. This MLIP was subsequently used to simulate large-scale, reactive molecular dynamics. We validated the MLIP's accuracy against Density Functional Theory (DFT) benchmarks. Ultimately, deepening our understanding of this catalytic mechanism provides critical insights for the rational design of more efficient zeolites, while simultaneously demonstrating the capability of MLIPs to accurately model complex, reactive zeolite systems.

042: EMENIKE, CHIMEREZE

Major: Mechanical Engineering - Bachelor of Science

University: Belhaven University

Faculty Research Mentor: Christopher Barrett, Mechanical Engineering

Funding: NSF REU: NSF REU: Computational Methods with applications in Materials Science, award #2348712

Project Category: Engineering

Simulation of Magnesium Defects under Concurrent Stress and Vibration using Interatomic Potentials

Magnesium is the lightest structural metal, and its strength-to-weight and stiffness-to-weight ratios give it great potential for weight reduction in various industries. However, it is brittle at room temperature due to its crystal structure, making it unfit for the manufacture of parts requiring stamping or rolling. Our research is concerned with the movement of defects critical to the ductility of magnesium under different conditions. In this project, we investigated the movement of a Pyramidal II edge dislocation in magnesium structures undergoing shear and oscillatory stress. We hypothesize that oscillating stress could help the dislocation move more quickly. This would suggest that vibrations could be applied in addition to forming stress during forming processes to improve the

ductility of Magnesium. We made use of machine-learned interatomic potentials to predict the behavior of our magnesium structures while undergoing shear and oscillating stress. We performed these simulations with the Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS) software package and visualized our results in OVITO. Our early results show the dislocation moving faster when an oscillating stress is applied.

043: GAUTAM, KAVYA

Major: Computer Science - Bachelor of Science

Faculty Research Mentor: Zhiqian Chen, Computer Science & Engineering

Co-Authors: Marouane Benbrahim, Zonghan Zhang, Zhiqian Chen

Funding: ORED Undergraduate Research Program

Project Category: Engineering

LLM-to-Map: Transparent Conversational Tool Orchestration for Real-Time Multi-Domain Simulation

Coupled power-traffic simulations are valuable for studying EV charging stress and outage propagation, but existing tools typically require scripts and opaque configurations. We present LLM-to-Map, a demo system that exposes a real-time multi-domain simulator through structured LLM tool orchestration. Natural-language requests are mapped to typed tool calls that coordinate SUMO traffic simulation, PyPSA power-flow analysis, V2G actions, and map operations. The agent operates over a fixed tool schema and emits auditable execution logs in the UI so users can inspect every action and parameter. Tool execution is deterministic: each request resolves to explicit API calls, and unsafe or destructive actions can require confirmation. The tool layer provides JSON schemas and parameter validation, preventing arbitrary code execution and enabling reproducible runs. The agent receives live system state (loads, EV statistics, V2G status, time, temperature) to support context-aware multi-step commands; when an LLM is unavailable, a deterministic parser preserves the same tool interface. The backend synchronizes cross-domain events (EV charging demand and substation failures) and streams state updates to a 3D map interface. We describe the architecture, coupling and synchronization, and a demo workflow that showcases multi-step scenario control and reporting for non-experts without writing scripts.

044: GAVINS, DUSTIN

Major: Industrial Engineering - Bachelor of Science

Faculty Research Mentor: Haifeng Wang, Industrial and Systems Engineering

Co-Authors: Joseph Dooley, Dr. Haifeng Wang, Amirhossein Eskorouchi, Christine Fortuin

Funding: US Department of Agriculture National Institute of Food and Agriculture through the Research and Extension Experiences for Undergraduate (REEU) fellowship.

Project Category: Engineering

A Deep Learning Application for Pine Fungal Disease Classification

Brown Spot Needle Blight (BSNB), Fusiform Rust (FR), and Annosus Root Disease (ARD) are three common fungal diseases that severely affect pine trees in the southeastern United States. Although estimates of economic losses vary, Fusiform Rust alone causes approximately 84 million dollars in damage each year across southern pines. Traditional manual visual observation techniques for diagnosing diseases are typically labor-intensive, inefficient, and significantly raise overhead costs, causing a certified arborist to conduct field inspections and lab tests. A more recent approach to early disease detection is UAV-based remote sensing imagery; however, this method presents its own cost barriers. In the notoriously tight-margin market for pine timber, drone platforms, remote-sensing payloads such as multispectral or LiDAR sensors, GNSS positioning equipment, and flight-planning and data-processing software represent a significant capital investment. These constraints limit widespread adoption, particularly among small-scale landowners and independent forest managers. This study proposes a low-cost alternative: ground-level image capture using a consumer mobile device, paired with a Convolutional Neural Network (CNN) for automated disease classification. A pretrained CNN was fine-tuned on in situ ground-level imagery of pine stands exhibiting BSNB, FR, and ARD, as well as healthy controls. Model performance was evaluated using five-fold cross-validation to ensure generalizability across varied field conditions. With the introduction of data augmentation, dropout regularization, and weight decay, validation accuracy was between 85% - 95%. Results suggest that mobile-based CNN classification is a viable, accessible diagnostic tool that could enable early detection.

045: GIRI, NIRANJAN**Major:** Computer Engineering - Bachelor of Science**Faculty Research Mentor:** Nayeon Lee, CAVS**Co-Authors:** Sungkwang Mun, Saugat Karki**Funding:** CAVS**Project Category:** Engineering**Automated Identification of Aluminum Alloys Through Impact-Induced Acoustic Emission Analysis**

Aluminum alloys are widely used across industries due to their favorable strength-to-weight ratio, corrosion resistance, and manufacturability. However, accurate identification, recycling and sorting of aluminum alloys remain challenging, often requiring manual inspection and specialized laboratory equipment. This research investigates the feasibility of classifying aluminum alloys through their acoustic and vibrational responses during controlled impact events, with the goal of developing a rapid and automated identification method. The study begins with the collection of aluminum samples from various alloy series. Each sample is prepared through surface grinding and analyzed spectroscopy to determine its chemical composition and establish a reliable ground-truth alloy classification. Following chemical characterization, samples are subjected to controlled drop tests in which impact-generated signals are recorded using multiple microphones and vibration sensors. The recorded signals are processed to extract relevant spectral and energy-based features that characterize the unique response of each alloy. Differences in material composition, density, stiffness, and internal damping properties are expected to influence the resulting acoustic signatures. By correlating spectrometer-based alloy classifications with sensor-derived features, machine learning techniques can be employed to develop predictive models capable of identifying aluminum alloys from impact data alone. The outcomes of this research contribute to the development of non-destructive and automated material identification systems for recycling, manufacturing, and quality-control applications. Such systems have the potential to reduce reliance on manual sorting processes and improve classification accuracy.

046: HALIBURTON, DAVIS**Major:** Electrical Engineering - Bachelor of Science**University:** University of Georgia**Faculty Research Mentor:** Vuk Marojevic, Department of Electrical and Computer Engineering**Funding:** NSF REU: 2348711**Project Category:** Engineering**Machine Learning Based Target Detection and Classification in an OpenISAC Software-Defined-Radio Testbed**

Integrated sensing and communication (ISAC) systems seek to enable wireless platforms that can both transmit information and sense their surrounding physical environment. This technology aims to alleviate the issue of spectrum scarcity as reliance on wireless systems increases. ISAC can improve systems where both communication and environmental awareness are important, including autonomous vehicles, industrial or manufacturing environments, smart cities or homes, and robotic systems. This project develops a machine learning pipeline for target detection and classification using sensing data collected from an OpenISAC software defined radio testbed operating at 3.5 GHz and aims to be applicable in a multitude of environments. Sensing matrices composed of IQ signals are captured from multiple scene conditions, empty, static objects, slow moving objects, and fast moving objects. From these matrices specific features such as per frame power statistics, regional energy features, and short window features are extracted over a duration of 200 frames and capture frame variation and motion sensitive changes. Several tree based ensemble classifiers, including Random Forest, Extra Trees, and Gradient Boosting models are trained and evaluated on the extracted feature data set. The project uses these trained models, with an accuracy of 88% in the base environment, and evaluates events captured with changed environments and changed objects to evaluate the robustness and general applicability of the classification models. Future work will focus on bringing this system into real time inference.

047: HOUSNA, ANIKA**Major:** Industrial Engineering - Bachelor of Science**University:** East Mississippi Community College

Faculty Research Mentor: Mohammad Marufuzzamman, Department of Industrial Engineering

Funding: This work is supported by the Agricultural Engineering project award no. 2025-68018-44227, 2024-67023-42727, and 2022-67022-37861 from the U.S. Department of Agriculture's National Institute of Food and Agriculture.

Project Category: Engineering

Detecting Cyber Security Attacks in Rural Forest Product Industries: Cyber Vulnerability Assessment and Machine Learning Model Development

Forest Product (FP) industries are increasingly exposed to cyber threats due to digitalization and network-based operations. Existing studies have focused on mainly general industrial systems, with limited research on detecting cyber security attacks in rural FP industries using multiple machine learning models. This study aims to gain a detailed understanding of the state of the rural forest product (FP) industry's cybersecurity practices; assess the risks and potential consequences stemming from cybersecurity vulnerabilities; evaluate cybersecurity technologies and their affordability; and gather stakeholder input to identify capability gaps in cybersecurity within the FP industry. Ten machine learning models were tested for cyberattack detection in the rural forest product industry using the NSL-KDD dataset. Random Forest achieved the highest accuracy of 99.72%, followed by Extra Trees (99.68%), Decision Tree (99.58%), Gradient Boosting (99.52%), Multilayer Perceptron (MLP) (99.30%), K-Nearest Neighbor (KNN) (99.18%), Support Vector Machine (SVM) (98.62%), AdaBoost (97.65%), Logistic Regression (97.40%), and Naïve Bayes (86.57%). The data show that tree-based approaches like Random Forest, Extra Trees, and Decision Tree have the highest accuracy for detecting cyberattacks in rural forest product companies, while Gradient Boosting, MLP, and KNN also perform well. SVM, AdaBoost, and Logistic Regression produce high classification results but have significantly lower accuracy. Naïve Bayes has the lowest accuracy among tested models, indicating it is less successful for cyberattack detection than other machine learning algorithms. These findings demonstrate machine learning's usefulness in boosting forest product industries' cybersecurity and imply that ensemble-based models are well suited for implementation in critical infrastructure to improve resistance to emerging cyber-attacks.

048: JOSEPH, RIKHI

Major: Computer Engineering - Bachelor of Science

University: California State University, Long Beach

Faculty Research Mentor: Ryan Green, Electrical and Computer Engineering

Co-Authors: Vivian Nguyen, Dr. Ryan Green

Funding: NSF REU: iEDGE (#2348711)

Project Category: Engineering

PSO-Based Optimization of Optically Transparent Waveguide Slot Antennas

According to the U.S. Environmental Protection Agency, a typical passenger gasoline-powered vehicle emits approximately 4.6 metric tons of carbon dioxide annually. As electric vehicles become more prevalent, improving vehicle efficiency has become critical. Unlike conventional vehicles, electric vehicles rely on finite battery capacity, making minimizing drag essential to maximize driving range. One source of aerodynamic drag is external communication antennas, which increases air resistance. One solution is to embed optically transparent antennas (OTA) directly into vehicle windows or windshields, eliminating the drag associated with external antennas. While promising, transparent conductive materials have lower electrical conductivity than conventional conductive materials used for antenna manufacturing, making it difficult to achieve high antenna performance. Researchers are investigating antenna topologies that can compensate for these material limitations. This project focuses on the optimization of a waveguide slot (WGS) OTA for connected vehicle applications. WGS antennas are known for their high gain and radiation efficiency, but using transparent conductive materials presents challenges due to manufacturing constraints. To address these challenges, this research gives a Particle Swarm Optimization script to optimize OTA gain and return loss while maintaining transparency, radiation efficiency, and manufacturability. The optimization framework integrates Python and ANSYS HFSS to generate pixelated geometries, automate simulations, and evaluate performance. Beyond improving the energy efficiency of connected electric vehicles through reduced aerodynamic drag, this research has applications in defense systems, medical technologies, and smart city infrastructure.

049: KATTA, ROSHAN

Major: Computer Science - Bachelor of Science

University: University of Texas at Dallas

Faculty Research Mentor: Jingdao Chen, Department of Computer Science & Engineering

Co-Authors: Nwokoye Chinwuba, Syed Mohammed Farhan, Ivan Fernandez

Funding: NSF REU: Cybersecurity

Project Category: Engineering

Cybersecurity for AI Robotic Systems

Name: Katta, Roshan Major: Computer Science Faculty Research Mentor: Dr. Jingdao Chen Funding: Undergraduate Research in Cybersecurity Counter-UAV detection has become a major research priority as the growing accessibility and operational capability of small drones create increasing risks to critical infrastructure, public safety, and secure airspace. The primary objective was to develop and evaluate sensor-specific baselines for drone detection and 3D localization using the MMAUD dataset, which includes synchronized RGB, LiDAR, radar, audio, and Leica ground-truth measurements. I trained and compared multiple YOLO models for RGB-based drone detection across five UAV platforms and established a strong visual benchmark. For the Livox Avia and Mid360 LiDAR sensors, I created complete pipelines for timestamp alignment, point-cloud preprocessing, candidate generation, and 3D position estimation. I also completed radar and audio localization baselines by evaluating geometric radar estimators, ROSbag-derived radar features, engineered acoustic features, and neural audio models, revealing strong near-boresight radar performance but limited standalone audio range accuracy. Each modality was tested independently to identify its accuracy, coverage, and sensitivity to noise, synchronization errors, and sensor geometry. These baselines provide a reproducible foundation for comparing sensor strengths and developing future multimodal fusion methods for more reliable counter-UAV perception.

050: LONDA, GILLIAN

Major: Mechanical Engineering - Bachelor of Science

University: University of Houston

Faculty Research Mentor: Bohumir Jelinek, CAVS

Co-Authors: Bohumir Jelinek

Funding: NSF REU: NSF REU: Computational Methods with applications in Materials Science, award #2348712

Project Category: Engineering

Refining and Scaling Particle-Based Soil Models

Wheel-soil interaction simulations are critical for evaluating the performance of off-road vehicles, construction equipment, and planetary exploration systems. The Discrete Element Method (DEM) provides a physics-based approach for modeling these interactions but requires significant computational resources, making efficient use of high-performance computing (HPC) systems essential. This project evaluates the parallel performance of the open-source YADE DEM Wheel-Soil Simulator, a simulation framework developed at Mississippi State University and based on the DEM soil model of Nakanishi et al. (2020). A benchmark simulation representing a fixed 6.3% wheel-slip condition was selected to provide a consistent basis for performance evaluation. Existing benchmark simulations were examined using multiple CPU thread configurations to characterize the current scaling behavior of the simulator. Execution-time data from previous simulations were collected and analyzed to establish baseline performance and identify existing benchmark cases. These results are being used to guide additional scaling studies across multiple computing platforms, including the Morrill and Hercules HPC clusters, with the objective of determining the optimal number of CPU threads for efficient simulation execution. Performance comparisons will be summarized using speed-up curves and execution-time analyses to evaluate parallel efficiency across different hardware architectures. To improve the reproducibility and maintainability of the simulation framework, a GitLab CI/CD workflow is also being implemented to automate simulation testing and validation using containerized YADE environments. The automated pipeline will provide continuous verification of simulation outputs while simplifying future software.

051: MISHRA, ASHWANI KUMAR

Major: Computer Science - Bachelor of Science

Faculty Research Mentor: Asad Malik, NSPARC

Co-Authors: Rohini Maram, Tim Reling, Asad Malik, Michael Taquino, Steven Michael Grice

Funding: None

Project Category: Engineering

PointZero: A Vision-Based, Stance-Aware Framework for Marksmanship Posture Correction

Marksmanship coaching instructions conventionally rely on a subjective and barely scalable Master-Apprentice paradigm. Current automated coaching models have demonstrated a profound syntactic gap. They provide very limited, opaque action classification rather than systematic and trace-able pedagogical correction. This study introduces PointZero: a software-defined and AI-based pipeline for autonomous marksmanship posture assessment and improvement. By monitoring monocular videos captured through a simple camera, the framework uses a custom deep learning-based pose estimation model by meticulously gauging skeletal topography. This includes capturing up to 75 total landmarks (33 body and 42 hand key points) per frame. PointZero uses deterministic geometric analysis without relying on purely predictive neural networks. It calculates a novel Torso Facing Ratio to automatically classify the shooter's stance. It derives precise biomechanical metrics, then evaluates deviations from hard-coded reference standards using an ontology-guided Large Language Model (LLM). The system successfully implements diagnostic algorithms that mirror expert human scrutiny. For instance, our Scapular Elevation Detection isolates hazardous "Tactical Turtle" posturing when vertical shoulder-to-nose normalization falls below an empirical threshold of 0.8. Evaluating an Isosceles stance, PointZero flags deviations against rigorous baselines, including a right/left elbow angle of $178^\circ \pm 5^\circ$, a knee bend of $165^\circ \pm 10^\circ$, and a forward torso lean of $10^\circ \pm 5^\circ$. By translating these kinematic realities into prioritized, text-to-speech coaching cues, this architecture aids scalable, objective, and inherently safer firearms training.

052: MUHLESTEIN, MATTHEW

Major: Computer Science - Bachelor of Science

University: Utah Valley University

Faculty Research Mentor: Zhiqian Chen, Department of Computer Science

Matthew Muhlestein, Marouane Benbrahim, Tamanna Rashme, Zhiqian Chen, Charan Gudla
Funding: NSF REU: Cybersecurity in Emerging Technologies

Project Category: Engineering

EditPrint: Detecting Knowledge-Editing Backdoors in Language Model Weights under Benign Fine-Tuning Drift

Knowledge-editing methods such as ROME and MEMIT can surgically alter a language model's weights to plant a hidden backdoor, producing a model that behaves normally until a secret trigger appears. Detecting such tampering is difficult in the realistic supply-chain setting, where a defender obtains a single candidate model and has no clean copy of it for comparison. We study whether a knowledge edit can be detected from weights alone when the candidate model has also undergone legitimate fine-tuning. We show that magnitude-based detection fundamentally fails: a ROME edit perturbs the weights by roughly 0.05%, while benign domain fine-tuning perturbs them by orders of magnitude more, so any size-based score flags heavily fine-tuned but innocent models more strongly than genuinely edited ones. We instead introduce a scale-free spectral signature that targets the localized, near-rank-one structure of an edit rather than its size, and we characterize detection performance as a function of benign drift. On GPT-2 XL, our detector attains AUC 0.911 with a 0.000 false-positive rate on low-drift candidates, degrading to AUC 0.754 across the full drift range. We further show that distributed edits (MEMIT) substantially evade detection, indicating a practical evasion strategy for adaptive attackers.

053: NGUYEN, VIVIAN

Major: Computer Science - Bachelor of Science

University: Virginia Tech

Faculty Research Mentor: Ryan Green, Electrical and Computer Engineering

Co-Authors: Rikhi Joseph, Dr. Ryan Green

Funding: NSF REU: iEDGE

Project Category: Engineering

Waffling Optimization Technique for Optically Transparent Small Medical Antenna

Glaucoma is a major health concern that affects over four million adults in the US. Current treatments typically involve eye drops, medication, and doctor visits. Appointments only provide snapshots of a patient's health, missing important changes in intraocular pressure between visits. Continuous intraocular pressure monitoring gives doctors a complete picture of a patient's condition, leading to better treatment decisions. Previous approaches have used sensors embedded in contact lenses that communicate with an external coil worn on the face. While these systems might provide near real-time data, they lack discretion, discouraging adoption. One possible solution to this is the integration of optically transparent antennas into smart glasses to create a more practical continuous monitoring system. While promising, the lower conductance of transparent thin films can reduce antenna performance, making it difficult to apply traditional antenna design topologies. This creates a need for optimization techniques that are designed specifically for transparent antennas. To address these challenges, this project uses a waffling optimization technique that divides the antenna surface into a grid and selectively removes conductive material to generate different antenna designs. Python automation is used to generate and validate each design before exporting it into ANSYS HFSS for simulation. Particle swarm optimization is then used to improve the design. Beyond glaucoma monitoring, this research has broader applications in areas such as connected vehicles, smart infrastructure, and defense systems, where optimized transparent antennas can provide wireless communication while maintaining optical transparency.

054: NWOKOYE, CHINWUBA

Major: Computer Science - Bachelor of Science

University: Washington and Lee University

Faculty Research Mentor: Jingdao Chen, Department of Computer Science and Engineering

Co-Authors: Roshan Katta, Ivan Fernandez, Syed Mohammed Farhan

Funding: NSF REU: Undergraduate Research in Cybersecurity

Project Category: Engineering

A Multi-Agent UAV Simulation Platform for Detection and Localization in Realistic Environments

As the presence and ability of unmanned aerial vehicles (UAVs) continues to increase, detection and localization systems for UAVs need to be developed just as quickly. It is necessary to detect and respond to such threats for when such devices are used in a malicious and adversarial manner. This research proposes a simulation platform capable of simulating both friendly and adversarial UAVs under realistic environmental conditions. The main limitation of traditional robotics simulators involves the inability to simulate multiple drones, inability to simulate realistic environmental artifacts, and limited sensing modalities. Our solution involves using an Isaac Sim environment along with multiple types of digital twin drones and sensors to accurately simulate UAVs under multi-agent settings, artificially-generated sensor degradation, and multiple sensing modalities including camera, LiDAR, radar, and audio.

055: ORR, HALEY

Major: Computer Engineering - Bachelor of Science

University: Virginia Tech

Faculty Research Mentor: Dylan Boyd, Electrical & Computer Engineering

Co-Authors: Elijah Frain & Joshua Oliver

Funding: NSF REU: iEDGE

Project Category: Engineering

Replacing Proprietary GNSS Receivers with Open-Source for Vegetation Optical Depth

Vegetation Optical Depth (VOD) estimates vegetation water content by measuring the attenuation of GPS signals as they pass through forest canopies. Existing VOD systems typically rely on proprietary GNSS receivers, making it difficult to determine how the received signals are processed before attenuation is calculated. VOD estimation depends on accurately measuring small changes in signal strength, so undocumented internal processing could alter measurements, making unreliable results. Instead, this project uses an open-source software-defined radio (SDR) receiver as a transparent alternative that allows the processing chain to be configured to the user's needs. As a result, open-source GNSS-SDR was modified to record satellite-specific tracking data, including carrier-to-noise density

ratio, GPS Time of Week, and satellite elevation angle throughout each observation. Using VOD visualization tools tailored for this project, signal strength measurements collected with the SDR were compared with those from a proprietary SparkFun GNSS receiver chip under open-sky and obstructed conditions to determine whether the open-source receiver can provide measurements suitable for VOD estimation while maintaining the transparency of the processing chain. RINEX observation files were also generated by the SparkFun to identify visible satellites and provide acquisition information for GNSS-SDR, thereby reducing the satellite search and enabling the targeted acquisition of satellites to assist with low-cost, hardware limitations. The correlation-based acquisition stage of GNSS-SDR was then benchmarked to identify computational bottlenecks and GPU implementations using CUDA and OpenCL were tested on an NVIDIA Jetson Orin Nano to accelerate signal acquisition using edge computing.

056: ORTON, ELIZABETH

Major: Biomedical Engineering - Bachelor of Science

Faculty Research Mentor: Adam Jones, Computer Science & Engineering

Co-Authors” Skye Lilienthal, J. Adam Jones, Zeenat Islam

Funding: NSF REU: NSF CISE REU

Project Category: Engineering

Developing Methods for Evaluation of Spatial Processing in VR Using EEG

Virtual reality (VR) is a technology with applications across medicine, education, and rehabilitation. Understanding its ecological validity — how what is learned in VR can be applied to the real world — is important for assessing its potential utility and effectiveness in these fields. One currently understudied element of the ecological validity of VR is how the brain processes the spatial information presented. A current model of spatial processing involves the dorsal and ventral streams, with the visual information about objects near the actor proceeding through the dorsal stream and objects farther away in the ventral stream. These streams are physically distinct from each other, which is useful in EEG studies that have a lower spatial granularity. The purpose of this study was to develop and test a framework for testing how visual processing of spatial information differs between the real world and VR. A fixation cross was presented at 70 cm and 170 cm from the participant while they were instructed to anticipate pointing at the cross and then point after a waiting period. For the VR setup, this stimulus presentation was mirrored using a virtual model of the lab environment. A 128-channel BioSemi EEG was performed during the stimulus presentation. The neural activity was then localized using LORETA to determine if the information is proceeding through the dorsal or ventral streams — if the stimuli is perceived as in the “near” or “far” space. The pilot data shows promise in differentiating between the dorsal and ventral streams for future purposes of determining how spatial processing differs in VR. Continued work will involve more participants to obtain more robust results.

057: OWENS, WESLEY

Major: Industrial Engineering - Bachelor of Science

Faculty Research Mentor: Yingbin Hu, Industrial and Systems Engineering

Co-Authors: Yingbin Hu, Ziao Guo, Prashidha Poudel

Funding: ORED Undergraduate Research Program

Project Category: Engineering

3D printer off road stabilization system

This research investigates the advantages of using a mechanical damping system to improve 3D printer print quality in mobile environments over various terrains. Hardware Design: A quasi-zero stiffness platform was engineered using 8 sets of 3D printed parallelogram mechanisms. This system restricts movement to the z-axis degrees of freedom. This system also allows for an effective stiffness of zero within a specific operating interval. Data Collection: Raw GPS, IMU, and Video data were collected and a python script was used to clean the data so it is usable. This script synced the GPS, IMU, and video data so that the print can be evaluated based on various conditions. Experimental validation: Prints were conducted on a Bambu Labs A1 using PLA filament. A scaled down pipe fitting was printed with a average print time of ~20 minutes. Tests were divided into 3 stages: regular stationary printing, printing under simulated vibration, and printing on the back of a moving vehicle. Results: The results demonstrated that printing while using the damping system significantly improved the quality of the part printed vs not using damping during vibration. Obvious layer misalignment was visible when printing without damping. The part quality was similar to that of

printing without vibration when using the damping system. Future developments: Focusing on continued evolution of the damping system along with an enclosure are the next steps of this research.

058: PIGOTT, KAYLA

Major: Industrial Engineering - Bachelor of Science

Faculty Research Mentor: Jason Street, Sustainable Bioproducts

Co-Authors: Tilak Neupane, Quinton Wiley, Bibek Bhatta, Niraj Gupta

Funding: USDA National Institute of Food and Agriculture- AI2F Research and Extension Experience for Undergraduates (REEU)

Project Category: Engineering

The AI of the Tiger: AI-Based Wood Pattern Classification of Tiger Stripe Wood Veneers

Traditional wood grain classification has focused on identifying wood species by analyzing unique anatomical features. However, current machine vision models are inadequate for industrial applications, especially in face-quality grading of wood veneers. Major challenges in machine-vision grading include the requirement for extensive model training, unclear grading standards, and complex industrial implementation. Recent studies have proposed methods for classifying the colors and textures of wood-grain veneers using machine vision. This study seeks to develop a machine-learning classification model that links veneer surface reflection and grain pattern to market value for industrial purposes. The training dataset comprises images from three grade classes (2A, 3A, and 4A), photographed under three lighting conditions (ring light only, small light only, and both ring and small light), collected from samples at Gibson USA in Nashville, Tennessee. Several lightweight Convolutional Neural Networks (CNNs) will be assessed to identify the most effective architecture for analyzing and processing the training images. Model performance will also be compared to determine the optimal lighting condition for image acquisition and classification. It is hypothesized that images captured under ring light only will yield the highest classification accuracy, as this illumination enhances contrast between reflective and non-reflective areas, thereby highlighting book-matching patterns and wood grain directions.

059: RAJAN, SHRIYA

Major: Chemical Engineering - Bachelor of Science

Faculty Research Mentor: Amin Amirlatifi, Associate Professor, Associate Director PATENT Lab, & Cleveland Endowed Professor

Co-Authors: Amin Amirlatifi

Project Category: Engineering

Analysis of "Viability of UiO-66 Impregnated with Silver for Carbon Capture by Tin Le

Analysis of "Viability of UiO-66 Impregnated with Silver for Carbon Capture by Tin Le

Carbon dioxide levels have been steadily increasing over the past decades; as of 2019 (411 ppm), CO₂ levels are at their highest in over 40 years (330 ppm in 1977); consequently, regulations in certain areas require the reduction of CO₂ emissions to combat this trend. For effective carbon capture, we require a sorbent that has high adsorption capacity, stability, and recyclability; in addition, an efficient and economical way to release the captured gas is needed as well. Metal-organic frameworks (MOFs) possess a high surface area for adsorption, but releasing the stored gases requires additional energy input that limits the overall efficiency of carbon capture. Ag/UiO-66 provides a thermally stable complex with a high surface for adsorption of CO₂ while the silver nanoparticles utilize light-induced local heating to act as a photoswitch for dynamic release of CO₂; visible light in the 400 nm spectrum is used to liberate the captured CO₂. The work seeks to capture carbon from the air and convert it into more usable end products. The present research aims to determine the viability of metal-organic frameworks with incorporated silver nanoparticles in capturing atmospheric carbon dioxide. Experiments are conducted in 20 degree Celsius pure CO₂ and air, with varying Ag loads, and different MOFs to determine the effectiveness of CO₂ capture.

060: ROBINSON, ANNA

Major: Computer Science - Bachelor of Science

Faculty Research Mentor: Vuk Marojevic, ECE

Co-Authors: Josh Moore, Vuk Marojevic

Funding: NSF REU: REU Undergraduate Research grant: 2348711

Project Category: Engineering

LSTM-RNN Autoencoder dApp for live anomaly detection in O-RAN networks

Due to the nature of 5G networks, there are many opportunities for sophisticated Denial of Service (DoS, typically an attempt to make a service unavailable by overwhelming it with requests) attacks which may be hard to detect with traditional security methods. This project follows the idea of using an xApp (eXtended Application, for optimizing specific network functions such as through use of machine learning) at the Near-Real-Time-RIC (a controller for optimizing the network performance) which leverages a Long Short-Term Memory (LSTM) and Recurrent Neural Network (RNN) Autoencoder to identify anomalous patterns characteristic of DoS attacks, and instead intends to analyze this approach with a dApp (long running process). This project is using O-RAN (Open Radio Access Network) technologies for the disaggregated front haul and open nature of it.

061: ROGERS, REEVES

Major: Physics - Bachelor of Science

University: Ohio University

Faculty Research Mentor: Ben Crider, Physics & Astronomy

Co-Authors: Benjamin Crider, Jichul Kim, Ronald Unz, Caden Teer

Funding: NSF REU: REU-INFEWS, Grant No. 2447730

Project Category: Engineering

An Open-Source, Low-Cost, Platform Independent System for Gamma-Ray Spectrometry Using Pocket Scintillation Detectors with Geant4 Validation

Radiological surveying and monitoring systems are essential for maintaining the safety of nuclear power plants and, in the unlikely event of an incident, ensuring effective disaster relief. Aerial radiation detection (ARD) systems have been a staple of nuclear security for decades, offering long-range, high-accuracy measurements during critical events, but high costs associated with manned aircraft have historically limited ARD to federal users. Advances in Unmanned Aerial Systems (UASs) over the last several years have made aerial surveying more accessible, providing comparatively low-cost platforms for ARD. The low cost of UAS-based systems also enables detector swarms, which can provide increased spatial coverage and redundancy compared to traditional single-platform approaches. At present, many detectors used on UAS-based ARD systems are expensive, often costing thousands of dollars, and heavy, requiring larger UASs to lift. These factors effectively limit ARD to larger research institutions. To address this gap, an open-source, lightweight, low-cost, platform-agnostic system has been built to evaluate the effectiveness of pocket-sized scintillation detectors for ARD. The system weighs under 0.5 kg, costs under \$1000, and is capable of real-time transmission of radiation and position data. By nature of the small detector volume, the system is most effective in short-range or small-scale environments, such as indoors or in known outdoor areas. This poster presents the design and implementation of the system, data collected during both test flights and test drives, and validation of detector performance through comparison with Monte Carlo simulations. This research was supported by the U.S. National Science Foundation under Grant No. 2447730 awarded to REU-INFEWS.

062: SADRI, ERFAN

Major: Computer Science - Bachelor of Science

Faculty Research Mentor: Vini Chaudhary, Department of Computer Science and Engineering

Co-Authors: Lucas Swanson

Funding: NSF REU: Cyber Security

Project Category: Engineering

Federated Multimodal Spectrum Sensing for Privacy-Preserving CBRS Spectrum Sharing

Wireless spectrum sharing is increasingly important as demand for reliable communication networks continues to grow. In the Citizens Broadband Radio Service (CBRS) band, Environmental Sensing Capability (ESC) systems help detect spectrum activity and support coexistence between different users. However, centralized spectrum sensing can require large amounts of signal data to be collected in one place, which may create communication and privacy concerns. This project investigates federated learning for spectrum sensing in a distributed ESC setting. Instead of

sending raw signal data to a central server, each ESC client trains locally and only shares model updates. The dataset was divided by signal-to-interference-plus-noise ratio (SINR) to represent different signal-quality conditions. A multimodal model combined IQ samples and spectrogram representations to classify overlap and no-overlap signal conditions. Experiments tested different learning-rate assignments, batch sizes, and communication rounds while keeping local training epochs fixed. The strongest fast-tuning result used a SINR-aware learning-rate strategy, with lower learning rates for noisier clients and higher learning rates for cleaner clients, reaching 98.33% aggregated local/client accuracy. Overall, the results show that SINR-aware federated learning is a promising approach for distributed and privacy-preserving spectrum sensing.

063: SHERPA, ASAHI LAMA

Major: Computer Science and Mathematics – Bachelor of Science

Faculty Research Mentor: Rizwan Farooqui, Building Construction Science

Vision Based Recognition of Construction Worker Activities and Ergonomic Risk Patterns

Manual review of construction videos can be time consuming and difficult to apply consistently. This project develops a low cost computer vision system that uses worker pose and movement features to recognize **common** construction activities and identify possible ergonomic risk patterns. A reproducible Python pipeline has been created to organize datasets, generate subject disjoint training, validation, and test splits, extract pose landmarks, calculate movement and posture features, and prepare baseline activity classifiers. The current dataset includes 20,928 construction related skeleton files from the Construction Motion Data Library and 2,773 videos from the Construction Working Postures Video Dataset. These videos represent 21 participants performing eight motions from multiple camera views. MediaPipe Pose has been used to extract body landmarks and create annotated videos for visual review. Logistic regression and random forest models have also been implemented for five provisional activity classes: carrying, kneeling, lifting or lowering, overhead work or reaching, and squatting. Full feature extraction and model validation are now in progress. Performance will be evaluated using precision, recall, macro F1 score, confusion matrices, and subject independent testing. Before the poster is prepared, the project is expected to complete baseline validation and add initial ergonomic indicators for repeated bending, overhead work, and kneeling or squatting duration. The final goal is an interpretable video-to-report prototype that can support human review without replacing professional safety or ergonomic assessment.

064: SHODHAN, SHIVANI

Major: Mathematics - Bachelor of Arts

University: Rice University

Faculty Research Mentor: Xinchao Liu, Industrial and Systems Engineering

Co-Authors: Xinchao Liu, Christine Fortuin, Jason Street, Seunghan Lee, Haifeng Wang, Mohammad Marufuzzaman

Funding: MSU REEU

Project Category: Engineering

AI-Assisted Autonomous Ultrasonic Nondestructive Evaluation via Spatial Uncertainty Modeling

Ultrasonic nondestructive testing (NDT) is used to detect hidden defects in test materials without causing damage. Conventional ultrasonic inspections rely on dense, uniform grid scans resulting in long inspection times and large volumes of redundant data because most measurements are collected from undamaged material. This research presents an AI-assisted autonomous ultrasonic inspection framework that adaptively determines where to scan next, enabling accurate defect localization using substantially fewer measurements than traditional approaches. A custom robotic scanning platform was developed by modifying a 3D printer to carry an ultrasonic probe over an aluminum specimen containing drilled defects. At each scan location, an A-scan is acquired and converted into C-scan signals. Damage-sensitive features are detected and compared with a reference model, robust covariance estimation is performed using the Fast Minimum Covariance Determinant Algorithm. The resulting novelty scores are modeled spatially with a Gaussian Process using a Matern-3/2 kernel that reflects the geometry of the ultrasonic probe footprint. The Gaussian Process simultaneously estimates defect likelihood and predictive uncertainty, interpolating unsampled regions. A Bayesian Optimization function then selects the next measurement location by balancing exploration of uncertain areas with exploitation of regions exhibiting high damage probability. Data collection terminates automatically once the predicted uncertainty approaches the estimated threshold. Because the finite probe

footprint can blur the apparent locations of small defects, a final sparse reconstruction step refines defect positions. This demonstrates success with lower scan time.

065: SILVA, PAULO SERGIO

Major: Electrical Engineering - Bachelor of Science

Faculty Research Mentor: Rizwan Farooqui, Building Construction Science

Co-Authors: Paulo Sergio Silva, Rizwan Farooqui, Abid Hassan

Funding: CAAD Catalyst Grant

Project Category: Engineering

HomeBridge: A Family-Connected Wearable System for Monitoring and Supporting Construction Workers' Mental Well-being

Mental health is an ongoing challenge in construction. This workplace involves high levels of psychological strain that affect workers' situational awareness, well-being, and decision-making, increasing incident risk. A technology-enabled and family-centered system was developed to address this problem. The system bridges the gap between workers and family members by using wearable physiological monitoring and communicating daily stress reports and evidence-backed well-being suggestions via automated messaging and a secure family-access dashboard. A wrist-worn PPG sensor and contact temperature sensor measure heart rate, heart rate variability, blood oxygen, and skin temperature, streaming data via BLE to a Jetson Orin Nano for on-site processing. Since PPG signals are highly susceptible to motion noise in construction settings, targeted signal processing and carefully chosen analysis windows ensure reliable heart rate and HRV estimation. A random forest classifier then calculates stress level on-site from heart rate, HRV, and temperature features. Results are sent to the cloud, giving family members secure dashboard access to daily stress summaries in plain language, along with more detailed metrics. The heart rate algorithm reached a 4.3 bpm mean absolute error on the PPG-DaLiA dataset, which captures subjects performing everyday activities under real-life conditions. The stress classifier, validated on WESAD using cross-subject testing, achieved 91% accuracy and an 84% F1 score. These results show the feasibility of accurate, field-deployable stress monitoring in high-noise occupational settings, laying groundwork for expanded field validation and more advanced classifier models to support construction safety and mental health.

066: SINGH, ADI

Major: Computer Science - Bachelor of Science

Faculty Research Mentor: Jonathan Whitlock, Department of Psychology

Project Category: Engineering

Can Your Eyes Reveal How You're Learning? Using Machine Learning to Decode Memory Strategy from Eye Movements

When we learn something new, the way our eyes move across a scene reflects the kind of memory we are forming. In this project, we asked whether a machine learning model could look at someone's eye movements during learning and predict what kind of memory strategy they were using, without any other information. Working with Prof. Jonathan Whitlock, we analyzed eye-tracking data from 83 participants who completed two different memory tasks. In one task, participants focused on remembering individual objects. In the other, they focused on remembering how objects related to their background scenes. These two strategies feel different psychologically, and we wanted to know if they look different through the eyes. We built a classifier that learned to distinguish between the two tasks using patterns in gaze behavior: where people looked, how long they looked there, how their eyes moved across the display, and how their scanning changed over the course of each learning episode. To test whether the model truly generalized, rather than just memorizing patterns, we validated it by training on 82 participants and testing on a completely new person, repeating this for every participant in the dataset. The result: the classifier correctly identified which memory strategy a participant was using on a given trial with strong and statistically significant accuracy, and it worked for 82 out of 83 participants individually. Notably, the single most informative signal was where participants looked in the very first second of viewing, suggesting that how we orient our attention at the start of learning already reveals the kind of memory we intend to form. This work demonstrates that memory encoding strategy leaves a detectable signature in eye movements — one that a machine can read, trial by trial, person by person.

067: SUN, PENGFEI

Major: Mathematics - Bachelor of Arts

University: New York University

Faculty Research Mentor: Junming Diao, Department of Electrical and Computer Engineering (ECE)

Co-Authors: Sunny Zhen, Junming Diao, Sirous Mohammadi

Funding: NSF REU: 2348711

Project Category: Engineering

7.5 dB Beamforming Gain from an 8-Channel SDR Patch Antenna Array: Toward Low-Cost Distributed Radio Telescopes

Detecting radio astronomical signals is challenging today. It requires a very large single antenna (e.g., FAST) or an antenna array; both are expensive and require a lot of land. Here, we introduce a method of using millions of IoT devices to form a massive array. In this report, we focus on a small-scale setup to evaluate our method. We fabricated 16 patch antennas with a frequency of 1.42 GHz as receiving antennas; after testing and tuning their frequency and bandwidth, we connected them to the USRPs to receive and analyze the data. We report an over-the-air experiment in a chamber completely isolated from interference, where an 8-element patch antenna array feeds an 8-channel software-defined radio (SDR) receiver built from 4 USRP B210 with two channels for each one. Two periodic antennas are installed on the tower as a calibrator and astronomy signal, respectively. In theory, coherent combining of the 8 channels after eigenvalue decomposition (EVD) calibration yields $10 \cdot \log_{10}(8) \approx 9$ dB of beamforming gain. Because of gain-received SNR variation by each element, the measured beamforming gain reached 7.5 dB against the ideal 9 dB. The demonstrated system is a concrete step toward distributed radio-telescope front ends built from low-cost commodity receivers.

068: THIBODEAUX, COLE

Major: Industrial Engineering - Bachelor of Science

Faculty Research Mentor: Haifeng Wang, Industrial and Systems Engineering

Co-Authors: Jason Street, Christine Fortuin, Mohammad Marufuzzaman, Amirhossein Eskorouchi, Prashidha Poudel, Joseph Dooley, Dustin Gavins

Funding: USDA AI2F REU

Project Category: Engineering

Development of a Modular AI-Powered Field Device for Forest Monitoring Applications

With the increasing emergence of AI technologies, the ability to utilize them in field-deployable tools opens doors for more advanced industrial and environmental monitoring. This project, part of the AI2F: Research and Extension Experience for Undergraduates in AI enabled Industrial Solutions for Forest Products, focuses on both designing and prototyping an AI-powered device suited for field data collection. The system utilizes components such as a Jetson Nano Developer Kit, a 7-inch HDMI touchscreen display, an embedded camera module, a detachable secondary camera, and a custom battery-powered enclosure. The purpose of this project is to develop and produce a portable, modular tool capable of supporting real-time image processing and AI-based inference tasks in remote forest environments. A design-test-refine cycle was utilized throughout the development process of this tool, starting with computer-aided design using SolidWorks and Fusion 360. Prototypes are produced using a PrusaXL 3D printer, allowing for quick and precise changes to be made. Immediate testing of the physical enclosure provided clear input on the success of each part's integration. This methodology emphasized iterative design grounded in durability, usability, and modularity for field deployment. Testing, using a trial-and-error base approach, was completed to evaluate and ensure the tools structural integrity and ease of assembly.

069: TONEY, PARKER

Major: Electrical Engineering - Bachelor of Science

University: Starkville Academy

Faculty Research Mentor: Daniel Carruth, CAVS

Co-Authors: Daniel W. Carruth and Timothy Sellers

Funding: None

Project Category: Engineering

Deploying Autonomy STACK on RC Car and Clearpath Robots

As ROS 1 approaches end-of-life, migrating to ROS 2 is essential for maintaining long-term support and compatibility with current robotics software. This project focuses on upgrading the autonomous ground vehicles in the CAVS DRIVE Lab from ROS 1 to ROS 2 to ensure their continued operability and relevance for future research. The migration process includes updating the underlying operating system, installing and configuring ROS 2, and integrating existing hardware components and sensors within the new framework. Following implementation, each vehicle's functionality is validated to confirm that autonomous performance is preserved or improved. Throughout the migration, compatibility issues between legacy and updated systems are identified and resolved, and communication between hardware and software components is systematically tested to ensure reliable operation. The solutions developed for these challenges are documented to serve as a reference for future ROS-based upgrades within the lab. The completed project establishes a stable, up-to-date ROS 2 platform that supports ongoing autonomous vehicle research, facilitates further software development, and enables integration of future hardware, thereby extending the operational lifespan of the DRIVE Lab's robotic systems.

070: TRAN, MAI VIET TAN

Major: Industrial Engineering - Bachelor of Science

University: Louisiana State University

Faculty Research Mentor: Jason Street, Department of Sustainable Bioproducts

Co-Authors: Tilak Neupane, Mandy Dreznick, Jason Street, Mohammad Marufuzzaman, Kayla Pigott

Funding: USDA - REEU - AI2F

Project Category: Engineering

Automated Wood Chip Species Identification Using Deep Learning and Computer Vision

Across the forest-products and bioenergy industries, knowing the species of incoming wood chips is essential to product quality, yet identification still relies largely on slow, subjective manual sorting. As these industries scale, there is a growing need for fast, automated, and non-destructive methods to classify wood chips by species. This study explores whether deep learning and computer vision can meet that need. Red Oak and Southern Yellow Pine, two economically important and widely processed species, serve as the test case. Using a custom dataset of individual wood chip images, several convolutional neural network architectures, including EfficientNet, MobileNet, and DenseNet, were trained and compared through transfer learning and two-stage fine-tuning. The study weighed the trade-offs that matter in practice, including accuracy against model size and performance against computational cost, and tested whether an ensemble of models could outperform any single one. Gradient-based interpretability methods, including Grad-CAM and feature-space visualization, were used to reveal what drives each prediction. Together, these analyses demonstrate a practical, generalizable approach to automated wood species identification and clarify which design choices most improve performance, laying groundwork that could extend to a broader range of species in industrial settings.

071: UPADHYAYA, SOMIN

Major: Computer Science - Bachelor of Science

Faculty Research Mentor: Xinchao Liu, Assistant Professor

Co-Authors: Xinchao Liu, Junfeng Ma

Funding: None

Project Category: Engineering

Language-Driven View Control on a Low-Cost Robotic Arm: Simulation and Physical Implementation

Autonomous robots capable of understanding natural language and acting on it remain costly and complex to deploy in real-world settings. This project explores this challenge from two directions: a simulation and a physical implementation. First, we built a simulation modeling a virtual robot performing assistive tasks for patients, offering a way to test and visualize robot behavior without the cost or risk of physical hardware. Second, we built a physical system exploring whether a low-cost, slightly imperfect robot arm can still be controlled effectively using natural language. We mount a camera on the arm and use CLIP, a pretrained vision-language model, to connect text instructions to what the camera should see. Because the arm doesn't move with perfect precision, we train a neural

network to learn the relationship between joint commands and camera view as a probability rather than a fixed outcome, with a small adjustable parameter that lets it adapt to different room layouts without retraining. We test this by rearranging objects on a desk and issuing open-ended instructions, measuring how accurately the arm locates the correct item. This object detection and view-control approach demonstrates that meaningful language-driven robot behavior is achievable even on inexpensive, imperfect hardware. Such a capability could have significant impact in fields like healthcare, where affordable, adaptable robotic systems could support tasks that currently require dedicated, high-cost equipment.

072: VEL, GUHAN

Major: Industrial Engineering - Bachelor of Science

University: Virginia Tech

Faculty Research Mentor: Seunghan Lee, Industrial and Systems Engineering

Co-Authors: Seunghan Lee, Jason T. Street, Christine Fortuin, Kevin Ragon, Xinchao Liu, Haifeng Wang, Mohammad Marufuzzaman

Funding: USDA

Project Category: Engineering

Spatiotemporal Forest Health Assessment Using Remote Sensing Data and Clustering Algorithms

Remote Sensing and Geographic Information Systems (GIS) have helped to increase the efficiency of forest health assessment and monitoring. Airborne imagery has made massive amounts of image data widely available, enabling the analysis of forests across the country. The project utilizes image data collected from the U.S. National Science Foundation's National Ecological Observatory Network (NSF NEON), consisting of imagery captured across multiple wavelengths to create different indices for assessing forest health. The three datasets examined were Fraction of Photosynthetically Active Radiation (fPAR), Leaf Area Index (LAI), and Albedo, which consisted of 1km x 1km aerial imagery of different areas. The goal of this project was to incorporate these indices and apply multiple clustering algorithms, including k-means and hierarchical clustering, to identify changes in forest health over time. Five sites were selected for analysis, yielding mainly four major clusters and helping to examine how health conditions changed over time. The resulting classifications were used to generate spatial maps of forest conditions and identify areas with relatively healthy, sparse, or potentially stressed vegetation. By comparing these classifications across locations and years, the proposed approach may help detect changes in canopy condition, vegetation density, and land-cover patterns. These results could support forest monitoring and resource management, as well as the identification of areas that may require further conservation efforts.

073: WILEY, QUINTON

Major: Sustainable Bioproducts - Bachelor of Science

Faculty Research Mentor: Ruben Shmulsky, Sustainable Bioproducts

Co-Authors: Tilak Neupane

Project Category: Engineering

AI-Enhanced Grading for Tiger Stripe Patterns in Wood for Solid Body Guitars

Figured maple *Acer* sp. is a highly valued tonewood used in the production of premium guitar bodies. The intensity and uniformity of the figure determine commercial grades, 1A being the lowest quality, and 7A being the highest. Conventional grading relies on visual inspection by experienced personnel. These grades correspond to different market values, making accurate and consistent grading important for both manufacturers and suppliers. Some grading rules include the presence of knots, the shape and intensity of the figure, and the straightness of grain. This process makes grading subjective and susceptible to inconsistencies. This study investigates the use of deep learning image classification models to automate the process of grading figured maple. This project focuses on developing models for classifying three veneer classes: 2A, 3A, and 4A. Images of maple billets of those grades were collected using a controlled imaging system with consistent camera positioning. To capture the chatoyancy of the figured maple, three images were taken of each sample under different lighting angles, which allowed for variation in figure intensity. The images will be divided into training, validation, and testing datasets. Various deep-learning architectures, such as ResNet and DenseNet, will be used to distinguish among the three figured maple grades. This

work explores the potential of combining controlled image acquisition with deep learning to provide a more consistent approach for grading figured maple used in guitar manufacturing.

074: WLOCHAL, MICHAEL

Major: Physics - Bachelor of Science

University: Coe College

Faculty Research Mentor: Doyl Dickel, Mechanical Engineering

Co-Authors: Dr. Doyl Dickel

Funding: NSF REU: NSF REU: Computational Methods with applications in Materials Science, award #2348712

Project Category: Engineering

Developing a Fitted Cutoff Function for MTP

Machine learning interatomic potentials (MLIPs) bridge the gap between high-accuracy quantum mechanics and high-speed classical force fields, enabling quantum-accurate, large-scale molecular dynamics. Cutoff functions, which smoothly truncate atomic interactions beyond a specific radial neighborhood are crucial due to their local scaling and computational efficiency. However, geometric constraints and boundary discontinuities—particularly at the short-range inner cutoff can cause severe force spikes and simulation instabilities. This work investigates Moment Tensor Potentials (MTP) with different cutoff functions using a diverse benchmark suite encompassing three distinct structural phases: bcc metals (Li, Mo), fcc metals (Cu, Ni), and diamond-structure semiconductors (Si, Ge) to span the range of crystal structures. The purpose of this work is to improve the potentials developed using the moment tensor methodology by shifting from a set cutoff function to a fitted spline cutoff function both built upon the Chebyshev polynomials for our radial basis functions. Using LAMMPS, we'll compare Density-Functional Theory (DFT) data with our results from molecular dynamics simulations for lattice parameter, elastic constants, bulk modulus, migration energy, and vacancy formation energy.

075: YAGEL, MAX

Major: Computer Science - Bachelor of Science

University: Clemson University

Faculty Research Mentor: Nitish Patil, Electrical and Computer Engineering

Co-Authors: Nitish Patil, Yu Luo

Funding: NSF REU: 2348711 (iEDGE)

Project Category: Engineering

Edge AI for Unitree Go1 EDU Autonomy: Natural Language to Motion

This paper expands on previous research on edge computing and integrating language models into robots for automated movement. Environmentally flexible robots have an increasing demand to automate physical tasks that would otherwise be tedious or dangerous. LLM technology can then be used to allow users to control these robots using commands with natural language instead of hard-coded options, improving the flexibility and accessibility of use. Our objective is to improve the efficiency pipeline from natural language processing to autonomous motion technology. This technology requires development in edge systems to remove unnecessary delays and dependencies on external web servers. Using a Unitree Go1 Robot Dog, YOLO image detection, and an Ollama LLM, we developed a system to have the robot perform specific actions based on prompts over a wireless network. To evaluate the performance of our system, we measured the rate in time at which the system could process and transmit data before generating the desired motion and compared the results to those of previous research. In the end, our system was able to consistently transfer data between the Go1 and the Jetson Orin Nano for image detection processing with YOLOv26m, which consistently reached 30 FPS. We found that the LLM took around 4 seconds to generate each motion command.

076: ZHEN, SUNNY

Major: Electrical Engineering - Bachelor of Science

Faculty Research Mentor: Junming Diao, Electrical & Computer Engineering

Co-Authors: Pengfei Sun, Sirous Mohammadi, Junming Diao

Funding: NSF REU: 2348711

Project Category: Engineering

7.5 dB Beamforming Gain from an 8-Channel SDR Patch Antenna Array: Toward Low-Cost Distributed Radio Telescopes

Detecting the radio astronomy signal is challenging today. It requires a very large single antenna (e.g., FAST) or an antenna array; both are expensive and require a lot of land. Here, we introduce a method of using millions of IoT devices to form a massive array. In this report, we focus on a small-scale setup to evaluate our method. We fabricated 16 patch antennas with a frequency of 1.42 GHz as receiving antennas; after testing and tuning their frequency and bandwidth, we connected them to the USRPs to receive and analyze the data. We report an over-the-air experiment in a chamber completely isolated from interference, where an 8-element patch antenna array feeds an 8-channel software-defined radio (SDR) receiver built from 4 USRP B210 with two channels for each one. Two periodic antennas that are installed on the tower as a calibrator and astronomy signal, respectively. In theory, coherent combining of the 8 channels after eigenvalue decomposition (EVD) calibration yields $10 \cdot \log_{10}(8) \approx 9$ dB of beamforming gain. Because of gain-received SNR variation by each element, the measured beamforming gain reached 7.5 dB against the ideal 9 dB. The demonstrated system is a concrete step toward distributed radio-telescope front ends built from low-cost commodity receivers.

077: ZUBELDIA, ITZIAR

Major: Computer Science - Bachelor of Science

Faculty Research Mentor: Zhiqian Chen, Computer Science & Engineering

Co-Authors: Marouane Benbrahim, Tamanna Rashme

Funding: NSF REU: Cybersecurity

Project Category: Engineering

Do Knowledge Editing, Prompting, or Fine-Tuning Actually Teach Code LLMs to Write Secure Code?

Code LLMs frequently generate insecure code, and a growing body of work proposes lightweight interventions to fix this. We ask whether these interventions actually work. We evaluate three intervention families knowledge editing (ROME/MEMIT), prompting, and parameter efficient fine tuning (LoRA) on OS command injection (CWE-78) in two code LLMs, Qwen2.5-Coder-7B-Instruct and CodeLlama-7B-Instruct, measuring security with hand-verified static analysis and capability with HumanEval+ pass@1, on a locked test set plus held-out prompt phrasings. None of the three generalizes. Knowledge editing attains rewrite accuracy near 1.0 while leaving the insecure rate exactly at baseline. Prompting yields a small improvement that vanishes on unseen phrasings. LoRA degrades security and capability together, and scaling the training set 3.5x makes both worse. Every method fails on held-out phrasings, on both models. We hypothesize a knowing-doing gap: the security knowledge is present but does not govern generation. Ongoing work tests this directly by measuring whether the models recognize and repair the vulnerabilities they themselves produce suggesting that knowledge-targeting interventions may be aimed at the wrong bottleneck.

PHYSICAL SCIENCES

078: BENNETT, AIDEN

Major: Physics - Bachelor of Science

Faculty Research Mentor: Benjamin Crider, Inst. for Clean Energy Technology

Co-Authors: Bailey Herring, Holly Miller, Ronald Unz

Funding: Department of Energy

Project Category: Physical Sciences

Automated Background Modeling and Validation for Geant4 Simulation of an Ortec Detective DX-100T HPGe Detector

Monte Carlo radiation transport simulations are an essential tool for evaluating radiation detection systems, enabling detector response to be studied across a wide range of source types, geometries, and operating environments without the cost and logistical challenges of extensive experimental testing. The accuracy of these simulations, however, depends on faithfully reproducing not only the source being measured but also the naturally occurring

radioactive background present in experimental spectra. Constructing realistic background models has traditionally required a labor-intensive process of determining the relative contributions and intensities of numerous environmental gamma-ray emitters before they can be incorporated into simulation. This work presents a novel automated methodology for reconstructing measured background spectra within the Geant4 simulation framework for an Ortec Detective DX-100T high-purity germanium detector. A ROOT-based analysis workflow was developed to automatically determine the photon energies and relative intensities required to reproduce measured background spectra, greatly reducing the effort required to generate realistic simulation inputs while improving reproducibility and consistency. The resulting simulated spectra are validated through direct comparison with experimental measurements acquired using the detector. By automating the generation of realistic background models, this methodology streamlines the development of validated detector simulations that can be readily extended to new measurement scenarios. Once validated, the simulation framework enables detector performance to be investigated across a broad range of source configurations and operating environments that would otherwise require extensive experimental campaigns.

079: BLANCHARD, BRIAN

Major: Chemistry - Bachelor of Science

University: Nicholls State University

Faculty Research Mentor: Todd Mlsna, Professor

Co-Authors: Ian Hartmann, Chathuri Peiris, R. M. Oshani Nayanathara, Todd Mlsna

Funding: NSF REU: Grant No. 2447730 awarded to REU-INFEWS

Project Category: Physical Sciences

Effect of Fiber Type on the Hydrophobicity of Lignocellulosic Materials

Due to poor biodegradability and ecosystem contamination, single-use plastic tableware items threaten wildlife and human health. While paper-based alternatives have emerged, their treatment with PFAS introduces secondary environmental concerns. Recent research highlights a more eco-conscious route to achieve hydrophobicity: altering lignocellulosic fibers with aqueous metal ions such as Zr(IV) and Fe(III). Immersing fibers in these solutions drives cellulose nanofibrils to form a denser microstructure while blocking hydrophilic hydroxyl groups. This project evaluates how distinct fiber types with varying lignin contents affect these modification outcomes. Using the Kappa number method, the lignin contents of wood-based cardboard and grass fibers were 9% and 10%, respectively. Fiber films were fabricated to test key process parameters, including metal-ion concentration, hot press temperature, and drying methods (wet vs. dry state), using water contact angle measurements and Cobb tests to quantify hydrophobicity and water absorption capacity. An anomaly occurred during concentration optimization: despite their similar lignin profiles, cardboard required a five-fold higher concentration of Zr(IV) (0.01 M) than grass (0.002 M) to achieve equivalent hydrophobicity. Furthermore, when treated with the baseline 0.002 M solution, grass films exhibited a drastically lower Cobb value (24 g/m²) than cardboard (140 g/m²). These findings confirm lignin content is not the sole determinant of modification efficiency; variations in fiber surface area and porosity likely drive this behavior. Ultimately, elucidating these mechanisms will aid the integration of metal-ion modifications into scalable paper production lines, yielding biodegradable alternatives to petroleum-based tableware.

080: BROCK, AUTUMN

Major: Chemical Engineering - Bachelor of Science

Faculty Research Mentor: Rajat Maji, Department of Chemistry

Co-Authors: Rajat Maji

Funding: NSF REU: 2447730

Project Category: Physical Sciences

Let It Bi: A Radical Approach to Sustainable Catalysis

Controlling stereoselectivity in excited-state reactions remains a central challenge in modern synthetic chemistry. Chiral salen ligands have long been recognized as versatile catalysts because they provide a defined chiral environment that enables highly selective asymmetric transformations. Their modular architecture also allows rapid structural modification, making them attractive platforms for catalyst development. Although metal-salen complexes have played a pivotal role in ground-state asymmetric catalysis, their application to excited-state photochemistry

remains largely unexplored. Heavy p-block elements such as indium and bismuth possess strong spin-orbit coupling, which can promote efficient intersystem crossing while offering advantages in terms of low toxicity, earth abundance, and cost compared to precious-metal photocatalysts. The objective of this research is to synthesize and characterize a new family of chiral salen ligands and their corresponding indium- and bismuth-based complexes for applications in asymmetric photoredox catalysis. Following synthesis, compounds are concentrated by rotary evaporation and purified using automated CombiFlash chromatography. The ligands and metal complexes are characterized by Nuclear Magnetic Resonance (NMR) spectroscopy and complementary analytical techniques to confirm their structures and purity. Currently focusing on optimizing ligand architectures to maximize heavy-atom effects, enhance intersystem crossing efficiency, and tune the photophysical properties. Ultimately, this work seeks to establish a class of chiral p-block photocatalysts that combine the modularity of salen ligands with the unique photochemical properties of indium and bismuth, providing a sustainable framework for asymmetric photoredox catalysis.

081: DOMANSKI, EDITH

Major: Chemistry - Bachelor of Arts

University: Barnard College of Columbia University

Faculty Research Mentor: Tim Schauwecker, Department of Landscape Architecture and Environmental Design

Co-Authors: Tim Schauwecker, Bailey Bullard, Todd Mlsna

Funding: NSF REU: NSF REU-INFEWS

Project Category: Physical Sciences

Assessment of Long-Term Phosphate Retention Trends in Engineered Biochar

Biochar is a substance made from the pyrolysis of organic matter, which is the burning of said matter without oxygen. Different types of biochar retain different properties. In particular, biochar made of Douglas fir has high surface area, which makes it easy to absorb materials such as phosphate. An abundance of phosphate, alongside other nutrients, may lead to eutrophication where an increase in algae leads to hypoxia and eventual ecological dead zones. The impact of biochar on phosphate levels and absorbance in Catalpa Creek was explored over five years. This was done using five bioreactors installed in gulleys by the creek, filled with chemically treated biochar and stabilized by slag. These bioreactors had samples of biochar taken out annually for five years, with the samples then being analyzed for phosphate absorption rates immediately after being ashed and phosphorus capacity after being submerged in phosphate-rich solutions. They were also analyzed for iron, magnesium, and phosphate using an inductively coupled plasma mass spectrometer (ICP-MS). The results suggested that, after five years, the phosphate capacity of biochar decreased significantly, only to increase back to near-initial levels in year five. Similarly, the amount of phosphate in the biochar increased at first, only to decrease rapidly in years three to five. These results suggest that the biochar isn't retaining phosphate as strongly as it did in years one and two, where it was able to mitigate some of the phosphate flow. Over time, the biochar's structure has likely degraded to a place where it cannot hold the phosphate as well, resulting in both an abundance of room for phosphate and a lack of ability to hold onto it.

082: FOTEDAR, MEDHA

Major: Physics - Bachelor of Science

University: Rice University

Faculty Research Mentor: Torsten Clay, Department of Physics

Co-Authors: Dr. Torsten Clay

Funding: NSF REU: Computational Methods with applications in Materials Science, award #2348712

Project Category: Physical Sciences

Dimensional Crossover and Suppression of the Spin-Peierls State

The Spin-Peierls (SP) transition is a classic phenomenon in low-dimensional quantum mechanics, wherein strong magnetoelastic coupling drives a structural lattice distortion, opening a spin gap and establishing a dimerized ground state. The SP transition is well understood in quasi-one-dimensional (quasi-1D) materials. In the organic charge-transfer tetramethyltetrathiafulvalene (TMTTF)₂X salts, pressure suppresses the SP transition, giving way to antiferromagnetism and then superconductivity. Pressure is expected to increase the two-dimensional character of the material but also to introduce geometric frustration and competing magnetic fluctuations. Our central question is whether these higher-dimensional effects suppress or destroy the SP state in favor of magnetic long-range order. In

this work, we test this dimensional crossover by performing extensive Density Matrix Renormalization Group (DMRG) calculations on a two-dimensional (2D) triangular-lattice Peierls-Hubbard model. Using a cylindrical geometry with open boundary conditions along the long axis and periodic boundary conditions along the circumference, we systematically sweep the interchain hopping parameter to move from decoupled 1D chains to a fully interacting 2D limit. To map the phase diagram and identify the transition from an SP state to an Antiferromagnetic (AFM) phase, the simulations measure electronic bond order and phonon displacement modulation amplitudes as primary SP order parameters, alongside the AFM diagnostic spin structure factor and charge structure factors. This numerical framework probes the survival threshold of magnetoelastic dimerization against competing magnetic orders in higher dimensions.

083: HUDSON, ASIYON

Major: Physics - Bachelor of Science

University: Tougaloo College

Faculty Research Mentor: Carl Lovely, Chemistry

Funding: NSF REU: Grant 2447730

Project Category: Physical Sciences

Concise Synthesis and Evaluation of Novel Bioactive B-Lactams

Heterocyclic compounds are found in many pharmaceuticals, making the development of efficient methods to synthesize and modify these molecules an important area of organic chemistry. Thiazole derivatives are important because they can be used to create molecules with potential pharmaceutical and biological applications. Under copper catalysis, two stereoisomeric lactams are formed, and this project focuses on optimizing the reaction conditions to favor their formation. This project investigates the reactivity of thiazole derived nitron intermediates and explores their potential to undergo [2+2] cycloaddition to form β -lactams or [3+2] cycloaddition to form five membered heterocyclic products. Thiazole derivatives were synthesized from N-methyl propargylamine and substituted isothiocyanates. The resulting compounds were reacted with nitrosobenzene to create reactive nitron intermediates. Cycloaddition reactions are being conducted to evaluate the products formed under different reaction conditions. Reaction progress is monitored using thin layer chromatography (TLC), and products are isolated by column chromatography for structural characterization using nuclear magnetic resonance (NMR) spectroscopy and mass spectrometry (MS). The synthesis of the thiazole starting materials and nitron intermediates have been successfully completed. Cycloaddition studies are currently ongoing, and product characterization will be used to determine which reaction pathway is favored. This research aims to improve our understanding of nitron reactivity and contribute to the development of efficient synthetic methods for constructing biologically relevant heterocyclic compounds with potential applications in medicinal chemistry.

084: JONES, ERIC

Major: Chemistry - Bachelor of Science

University: Fayetteville State University Fayetteville, NC

Faculty Research Mentor: Charles Webster, Professor

Co-Authors: Garrett Wells, Samuel D. Juarez-Escamilla, T. Keith Hollis, Charles Edwin Webster

Funding: NSF REU: REU in Computational Methods with Applications in Materials Science

Project Category: Physical Sciences

Computational Design and Synthesis of Lanthanide Pincer Complexes for Blue-Light Emission

Blue OLED emitters are often called the "holy grail" of display technology because they are used to make attractive vibrant colors for lighting and devices. However, they are often unstable and susceptible to faster burnout over time when compared to compounds that produce other colors. Red, blue, and green emitters are important and necessary in a device for white light. Thus, an objective in research is producing a stable blue emitter with an extended lifetime and higher quantum yield. Lanthanides, which are metals from the f-block of the periodic table, are used for their photoelectronic properties. These properties can be modified by attaching different ligands to the metal center. Pincer ligands can confer thermal stability to the metal complex. In this work, lanthanide pincer complexes were studied to find candidates that emit blue light with extended lifetimes and high quantum yields. Computational analyses were done using a tight-binding approximation (g-xTB) to find stable structures of the lanthanide complexes.

The lanthanides investigated were Ce (3+, 4+), La (3+), and Gd (3+, 4+), while the pincer ligands were of CCC, NCN, and CNC type. The number of bound ligands was also investigated (1, 2 or 3 ligands on the metal at a time). 1,752 structures were tested for their coordination chemistry. From these structures, suitable candidates were then targeted for synthesis and further investigated using DFT and TDDFT within Gaussian16 to simulate their ground and excited state character.

085: LEWIS, JESENY

Major: Chemistry - Bachelor of Science

University: Mississippi Christian University

Faculty Research Mentor: Steven Gwaltney, Department of Chemistry

Co-Authors: Loan Nguyen, Steven R. Gwaltney

Funding: NSF REU: NSF REU: Computational Methods with Applications in Materials Science, award #2348712

Project Category: Physical Sciences

Modeling RNA Delivery & Release by the Charge-Shifting Polymer te-pDMAEMA

Charge-shifting polymers are highly effective at binding nucleic acids during transport and releasing them once inside target cells. This project investigates the chemical behavior of te-pDMAEMA, (poly[2-(dimethylamino) ethyl thiomethacrylate]), and the interactions between an RNA molecule and te-pDMAEMA within a water and NaCl solution that aims to mimic the cellular environment. H2B-mCherry is an RNA sequence that codes for the mCherry fluorescent protein. Molecular dynamics simulations are the methods used to analyze and visualize the physical movements of these molecules over time through Newton's laws of motion. These tools were used for polymer building, optimizing conformers, calculating equilibrium geometries, and calculating partial atomic charges. This study aims to improve understanding of polyplexes involving RNA delivery systems and to contribute information towards these electrostatic interactions.

086: PITTMAN, MARY

Major: Mathematics - Bachelor of Science

University: Belmont University

Faculty Research Mentor: Amanda Diegel, Department of Mathematics and Statistics

Co-Authors: Kasuni Imalsha Sehani Edirisinghe Dewage

Funding: NSF REU: NSF REU: Computational Methods with applications in Materials Science, award #2348712

Project Category: Physical Sciences

Continuous Data Assimilation for Geophysical Flow

We consider continuous data assimilation, a numerical method which incorporates known data, to model geophysical flow. Geophysical flow simulations are important to weather and ocean modeling, the study of climate change, modeling pollutant transport in the ocean, and many other areas. We study the barotropic vorticity model, which tracks fluid vorticity and the streamfunction, using the finite element method with continuous data assimilation. Utilizing MATLAB with the finite element C++/MATLAB toolbox FELICITY, we seek to answer whether incorporating known vorticity data, but not streamfunction data, into the numerical simulation in real time with lead to long-term accurate approximate solutions even if the simulation is given incorrect initial conditions.

087: SHASTRI, ATHARVA

Major: Chemical Engineering - Bachelor of Science

University: Texas A&M University

Faculty Research Mentor: Sean , Joseph Stokes, Emerson, Chemistry

Co-Authors: Bhupendra Adhikari, Ethan Bush, Sean Stokes, Joseph Emerson

Funding: NSF REU: NSF REU- Chemistry

Project Category: Physical Sciences

Pyridyl-Triazole-Oxazoline Hybrid Ligands for Asymmetric A³ Coupling

Propargylamines are valuable synthetic intermediates for the preparation of nitrogen-containing heterocycles, natural products, and pharmaceutical compounds, making the development of efficient catalytic methods for their synthesis

an important area of research. The aldehyde–amine–alkyne (A^3) coupling reaction provides a straightforward one-pot approach to propargylamines. This reaction is commonly catalyzed by first-row transition metals, which activate the alkyne toward addition to an in situ generated iminium intermediate. As an atom-economical process, it avoids the use of stoichiometric organometallic reagents and multi-step synthetic routes, and it can also be made enantioselective by employing chiral ligands. Herein, we report the synthesis of a new class of pyridyl–triazole–oxazoline ligands and their coordination with first-row transition metals such as Cu and Ni to form bi-, tri-, and tetradentate N-donor complexes for evaluation in A^3 coupling reactions. Chiral oxazoline frameworks are widely used in asymmetric catalysis because of their easily tunable donor properties. Based on this concept, we synthesized an indeno-oxazoline containing a chloromethyl group, which was further functionalized with pyridine and triazole N-donor units. The triazole moiety was introduced via click chemistry due to its high efficiency, reliability, and excellent compatibility with nitrogen-rich ligand frameworks. The reaction intermediates and the final triazole–oxazoline ligands were characterized using 1H , ^{13}C NMR spectroscopy and electrospray ionization mass spectrometry (ESI-MS). These indanyl–oxazoline–triazole hybrid ligands are promising candidates for coordination with transition metals and for application in asymmetric A^3 coupling and other related catalytic reactions.

088: UNPINGCO, DANIELLA

Major: Chemistry - Bachelor of Science

University: St. Mary's University

Faculty Research Mentor: Sidney Creutz, Chemistry

Co-Authors: Md Abu Rayhan Khan, Sidney Creutz

Funding: NSF REU: NSF REU Grant 2447730

Project Category: Physical Sciences

Synthesis of Homo-bimetallic Copper Complexes for the Activation of Small Molecules

Catalysts are essential for accelerating chemical reactions and activating inert small molecules such as CO_2 , N_2 , and H_2 . Homo-bimetallic complexes are highly promising for this purpose because cooperative interactions between two adjacent metal centers can significantly enhance catalytic reactivity. To study these cooperative effects, a multistep synthetic pathway was designed to construct a homo-bimetallic copper complex. The synthesis involves a bridging ligand framework that holds the two copper centers in close spatial proximity, allowing for the necessary electronic and geometric cooperation between the metals. As part of developing this bimetallic platform, a series of ligand derivatives containing different substituents were investigated to explore their effects on the synthesis of the target complex. By optimizing reaction conditions and selecting appropriate precursors, the multistep synthesis aims to produce the desired bimetallic copper complex. The resulting complex will be characterized using nuclear magnetic resonance (NMR) spectroscopy, high-resolution mass spectrometry (HRMS), UV-Vis spectroscopy, and single-crystal X-ray diffraction (SCXRD) to confirm its composition, molecular structure, and coordination environment. Ultimately, this work aims to develop a bimetallic platform that can be used to study how metal–metal cooperation improves the activation of small molecules and enhances catalytic reactivity.

089: WESTON, HEATHER

Major: Chemical Engineering - Bachelor of Science

University: University of North Alabama

Faculty Research Mentor: Steven Gwaltney, Chemistry

Co-Authors: Loan Nguyen, Steven R. Gwaltney

Funding: NSF REU: REU in Computational Methods with Applications in Materials Science, award #2348612

Project Category: Physical Sciences

Modeling mRNA Delivery & Release by the Charge-Shifting Polymer pDMAEMA

Poly(2- (dimethylamino) ethyl) methacrylate (pDMAEMA) is a charge-shifting polymer that can be attached to genetic material like mRNA and that aids delivery into cells. pDMAEMA has been studied in vitro to determine its intercellular interactions, but the intracellular mechanisms are not well understood. However, using computational chemistry methods like molecular dynamics (MD) simulations, we observed intracellular mechanics at an atomic level to understand the delivery and release of mRNA into a cell with pDMAEMA polymers. This was accomplished by completing individual MD simulations of pDMAEMA and mRNA. Initial simulations were completed of pDMAEMA decamers. Following that, the mRNA sequence that encodes the H2B-MCherry fluorescent protein was simulated. This

protein was used as a convenient indicator if the mRNA reaches the cells. Finally, the polymer and mRNA were combined in simulations to understand their interactions with each other and their cell delivery mechanisms. Gaining understanding of how pDMAEMA releases mRNA could pave the way to more variety in the delivery of gene therapies, which will allow for treatment of currently untreatable disorders. This research will also help further in vivo and in vitro research to understand the real implications of using pDMAEMA as a delivery mechanism of mRNA into cells and how it impacts cells post-mRNA release.

090: WILLIAMS, JANE

Major: Physics - Bachelor of Science

University: Texas Tech University

Faculty Research Mentor: Torsten Clay, Department of Physics and Astronomy

Funding: NSF REU: NSF REU: Computational Methods with applications in Materials Science, award #2348712

Project Category: Physical Sciences

Two Dimensional crossover of Cuprate Ladders

The cuprate $\text{Sr}_{14-x}\text{Ca}_x\text{Cu}_{24}\text{O}_{41}$ is the only known ladder cuprate superconductor, exhibiting a maximum superconducting transition temperature of approximately $T_c=9$ K under an applied pressure of 4.5 GPa. Prior to the onset of superconductivity, the material exhibits increasingly two-dimensional electronic behavior as inter-ladder coupling strengthens. Negative charge-transfer energies, are predicted to further enhance inter-ladder coupling, motivating the study of larger coupled-ladder systems. This work employs the Constrained Path Quantum Monte Carlo (CPQMC) algorithm to extend previous studies from two coupled ladders to larger ladder geometries. Simulations were performed for 2×8 ladders (32 Cu and 44 O sites; 76 total orbitals) and 4×8 ladders (64 Cu and 88 O sites; 152 total orbitals) and 4×16 ladders (128 Cu and 184 O sites; 312 total orbitals), over a range of hole dopings and charge-transfer energies. Bond orders and charge densities were calculated and compared between the Density Matrix Renormalization Group (DMRG) results and our 2×8 CPQMC calculations. Excellent agreement with DMRG validates the accuracy of CPQMC, while the larger 4×8 , and 4×16 systems reproduce the trends observed in smaller ladders across the range of doping levels and charge-transfer energies studied. These results demonstrate that CPQMC provides an accurate and computationally efficient framework for investigating larger coupled-ladder systems and their evolution toward two-dimensional electronic behavior. Our results confirm the enhancement of inter-ladder coupling in the negative charge transfer regime.

SOCIAL SCIENCES

091: BREWER, TRISTAN

Major: Secondary Education - Bachelor of Science

Faculty Research Mentor: Qiana Cutts Givens, Counseling, Higher Educational Leadership, Educational Psychology, and Foundations

Funding: None

Project Category: Social Sciences

The History of Federal Policy on Religious Expression in United States Schools: A Critical Examination

The United States' history is steeped in religious conflict. From the settlement of the New World to current-day headlines, religion has molded political and cultural discussion and debate. Ultimately, the United States describes itself as operating without an established national religion. Yet over the past several decades, several court cases have challenged this claim, especially in relation to schools. This project attempts to provide a brief history of federal proceedings relating to the expression of religion in United States schools and the effects of federal policy and rulings on religion in United States schools, with an emphasis on public schools. Analysis focuses on creating a timeline of events by examining court cases and other legal proceedings alongside secondary sources to gather an understanding of what educational policies were put in place in different eras of United States history, as well as the reasons for these policies. Crucial Supreme Court rulings are identified, and their effects are discussed at length to offer a backdrop against which to compare current precedents seen in judicial cases regarding religion in schools. I use these precedents and rulings to fuel discussion around the ways religious expression has been stifled by the culture that has been created in schools, and the more recent ways this culture has started to change.

092: BROWN, VICTORIA**Major:** Psychology - Bachelor of Science**Faculty Research Mentor:** Samuel Murphy, Psychology**Co-Authors:** Samuel Murphy**Funding:** None**Project Category:** Social Sciences**Positive Thinking Under Pressure: How Anxiety Shapes Perceived Coping Skills Credibility**

The present study examined whether anxiety symptoms influence how credible college students perceive different emotion regulation strategies to be after experiencing a negative mood state. Participants were 234 college students aged 18 to 51 who completed a measure of anxiety symptoms using the Generalized Anxiety Disorder Scale-7 (GAD-7). Participants were then randomly assigned to either a mood induction condition or a control condition, followed by random assignment to complete either a Positive Thinking worksheet or a Cognitive Restructuring worksheet. After completing the assigned strategy, participants rated the credibility of the intervention. Results suggested that anxiety symptoms may moderate the effect of mood condition and the credibility of coping strategies. In the control condition, students with lower anxiety symptoms generally rated both Positive Thinking and Cognitive Restructuring as more credible than students with elevated anxiety symptoms. However, after mood induction, students with elevated anxiety symptoms rated Positive Thinking as more credible than students with lower anxiety symptoms. These findings suggest that the perceived helpfulness of coping strategies may depend on both a person's current emotional state and their level of anxiety symptoms. Positive Thinking may feel especially credible for individuals with elevated anxiety after experiencing negative emotion, possibly because it provides a sense of relief or emotional contrast. These results highlight the importance of considering individual symptoms when evaluating the perceived usefulness of brief emotion regulation strategies. Keywords: anxiety, mood induction, positive thinking, cognitive restructuring, credibility.

093: CULWELL, ROBERT**Major:** Ag Eng Tech & Bus - Bachelor of Science**Faculty Research Mentor:** Molly Nicodemus, Animal & Dairy Sciences**Co-Authors:** Emily Curran, Emma Farnlacher, Emma Morgan**Funding:** None**Project Category:** Social Sciences**Innovative Programming: Campus-Based Student Wellness Event Using Stereoscopic Virtual Reality Equine Interaction**

Mental health concerns among college students have increased substantially since the COVID-19 pandemic, with persistent challenges related to anxiety, depression, and academic performance. Universities have expanded wellness initiatives, including animal-assisted and nature-based interventions, to support student well-being. Equine-assisted experiences (EAE) have demonstrated potential to promote emotionally safe learning environments; however, access to horses and equine facilities remains limited on most campuses. To address this barrier, a stereoscopic virtual reality (VR) equine interaction program was developed and implemented at Mississippi State University. The first step to offering this program included recording of equine interactive activities using a GoPro HERO 10 camera. Videos were loaded onto Meta Quest VR headsets, allowing students to experience immersive, three-dimensional equine interactions. Two VR headsets were made available during student wellness events conducted in the fall semester of 2024 and 2025. Events were hosted in both classroom and equine facility settings and promoted through campus announcements, flyers, and social media. Participation was voluntary, with no restrictions on duration of use. A total of 40 students participated across three events, including 31 participants in fall 2024 and 9 participants in fall 2025. Individual VR exposure ranged from 6 to 42 minutes. Reported challenges were minimal, including headset weight, concerns about hairstyle disruption, and occasional dizziness. Despite these limitations, all participants reported an improved emotional state following VR EAE. Findings suggest this approach offers a scalable model for supporting student mental health through innovative virtual ecotherapy programming.

094: CULWELL, JULIUS

Major: Ag Educ., Leadership & Comm - Bachelor of Science

Faculty Research Mentor: Molly Nicodemus, Animal & Dairy Sciences

Co-Authors: Kaitlyn Butze, Emma Morgan, Allison McClure

Funding: None

Project Category: Social Sciences

Grooming-Based Equine-Assisted Experience to Support College Student Emotional Well-Being: A Pilot Evaluation

Growing concerns regarding college student mental health have driven interest in innovative interventions that promote emotional well-being. While equine-assisted experiences (EAE) have been associated with positive psychological outcomes, evidence-based approaches for implementing EAE programs within university settings remain limited in investigation. This study aimed to develop and evaluate an on-campus grooming-based EAE program designed to support college student emotional well-being. A grooming-focused EAE curriculum was developed in collaboration with the Mississippi State University Extension Equine Assisted Services Program. The curriculum targeted stress reduction, mindfulness, cognitive engagement, emotional regulation, and social connection. The curriculum was implemented during a student wellness event at the university equine facilities during spring semester finals week. Participants were recruited through social media and classroom announcements. Physiological stress was measured using wearable monitors that continuously tracked heart rate during the session, and perceived emotional state was evaluated by having participants completing post-session interviews. All participants ($n = 9$) reported an improved emotional state following the session. Mean heart rate did not differ significantly between pre- and post-session measurements (83.2 ± 8.4 vs. 89.4 ± 11.1 bpm; $P = 0.08$). However, a significant difference was observed between minimum and maximum heart rates recorded during the session (73.1 ± 8.1 vs. 105.4 ± 12.1 bpm; $P < 0.05$), with peak values occurring midway through the session. Despite the physical nature of grooming, heart rates remained within normal resting ranges throughout the session with one participant demonstrating the lowest heart rate post-session. Participant feedback and physiological measures suggest that a grooming-based EAE program may support emotional well-being among college students, however, further investigation is warranted.

095: KATUWAL, ROYAL

Major: Economics - A&S - Bachelor of Arts

Faculty Research Mentor: Rui Wang, NSPARC

Co-Authors: Sandip M C, Townes Fulford, Daniel Adejumbo

Funding: None

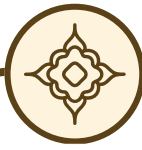
Project Category: Social Sciences

Early Evidence on the Employment Effects of Artificial Intelligence in the United States

Artificial intelligence (AI) has advanced rapidly in recent years, raising one of the most important questions: how AI affects employment and the labor market. Understanding these impacts is essential for policymakers seeking to support workers who may be vulnerable to AI-driven disruption. Although a growing body of research has examined AI's potential labor market impacts, most studies are forward-looking and focus on projected effects rather than observed changes in employment. Few have conducted a comprehensive historical analysis of AI's impact on the U.S. workforce. This study addresses that gap by providing one of the first historical assessments of AI's potential impact on U.S. employment. To identify occupations at greater risk of AI displacement, the study develops a composite AI vulnerability index that extends beyond conventional measures of AI exposure by incorporating factors related to an occupation's resilience to automation, including demand resilience, the degree of human judgment required, the need for physical presence, and the level of responsibility and decision-making involved. The index identifies more than 120 occupations as having a high risk of AI displacement. Using the public release of ChatGPT in November 2022 as a proxy for the widespread availability of generative AI, the study compares employment trends in these high-risk occupations before and after its release. The results show that a subset of these occupations experienced employment declines, providing early evidence that AI may already be reshaping segments of the U.S. labor market. The analysis also identifies the states and metropolitan areas where these employment changes appear to be most pronounced.

096: ROBERTSON, IAN**Major:** Criminology - Bachelor of Arts**Faculty Research Mentor:** Margaret Ralston, Sociology**Co-Authors:** Dr. Margaret Ralston, Dr. Sanna King**Funding:** ORED Undergraduate Research Program**Project Category:** Social Sciences**An Investigation of the Long-Term Consequences of School Suspension and Expulsion on Mental Health**

School-based punishment has been a long-standing tool in the socialization of children in the United States. Previous studies have shown that suspension and expulsion can have adverse effects, such as increased risk of contact with the criminal justice system and worsened chances of educational attainment. However, little research has been done on the effects that these forms of punishment may have on a person's mental health. This study effectively progresses previous research by highlighting the impact on depressive symptoms that in-school suspension (ISS) may have as a student matures into adulthood. By using a life-course perspective, this study investigates social support as a potential intervening mechanism in the relationship between punishment and depressive symptoms, as it examines how disciplinary experiences during adolescence may shape mental health outcomes in adulthood. We use Waves I-VI of the National Longitudinal Study of Adolescent to Adult Health (Add Health) data and regression analysis to investigate the effect of childhood school punishment on adult mental health outcomes. Respondents are between the ages of 39 and 51 in Wave VI, the study seeks to tie current depressive symptoms to instances of school-based punishment in their youth. The expected outcome of the study is to find that depressive symptoms may be higher in adults that experienced in-school suspension as a child. This study fills in important gaps in existing literature by tying in important sociological environments in the life of children who grow up to exhibit signs of potentially life-altering mental disorders.



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