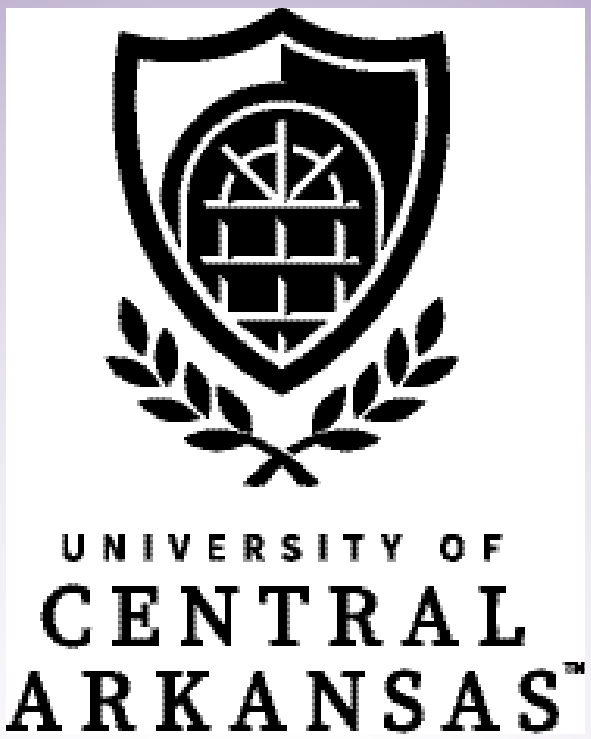

College of Natural Sciences and Mathematics

24th Annual Student Research Poster Symposium

Farris Center
April 20, 2018
1:00 - 3:00 PM

Welcome from the Dean
College of Natural Sciences and Mathematics

Welcome to the 24th Annual College of Natural Sciences and Mathematics Student Research Symposium. Today you will see some of the research that is being undertaken by students in the College. This year we have research from many fields - there are 84 posters involving 110 students mentored by 42 different faculty members. We encourage you to drop by the Farris Center to join us in celebrating the accomplishments of our students.

I look forward to seeing you there.

Cordially,

Stephen R. Addison

Stephen R. Addison, Dean
College of Natural Sciences and Mathematics

UNIVERSITY OF
CENTRAL
ARKANSAS

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Department of Biology

Effects of Cadherin-18 on Fetal Kidney Cell Aggregation

Andrew Baker
Faculty Mentor: Calin O. Marian

Cadherins are a group of transmembrane calcium-dependent adhesion proteins found in mammalian cells. These proteins are generally categorized into two classes: Type I and Type II cadherins. Type I cadherins (e.g. E-cadherin and N-cadherin) are the best understood, and are well-established as functioning in cell-cell adhesion and recognition. Type II cadherins lack the HAV motif present in Type I cadherins, which is known for playing a significant role in adhesion, so the overall function of these cadherins is still largely unknown. Here we are interested in a Type II cadherin known as cadherin-18 (CDH18). Previous experimentation has shown CDH18 to be associated with other proteins such as β-catenin, which are known to be involved in regulation of cell-cell adhesion. For these experiments, we characterized the adhesive properties of this protein using human embryonic kidney cells that were engineered to over-express CDH18. In these experiments, we attempt to characterize the adhesive properties of CDH18 using a series of cellular aggregation assays.

DNA Isolation from Various Blood Cell Fractions of Red-eared Sliders

David Baker, Emily Chambers, Elias Smith
Faculty Mentor: Calin O. Marian

Red-eared slider turtles (*Trachemys scripta elegans*) have nucleated red blood cells (RBCs), like many other reptiles. Trachemys scripta RBCs can therefore provide ample DNA for analysis. In addition to RBCs, white blood cells (WBCs) can be isolated from whole blood using differential centrifugation over a Histopaque layer. This provides an additional source of genetic material, which may be examined in comparison to the genetic material of the RBCs. We isolated the RBC and WBC fractions with a high degree of purity and have extracted DNA from these fractions in several turtles. The turtle blood DNA will be used for subsequent experiments to establish a potential correlation between telomere lengths and age in chelonians.

Establishing The Relationships Among Land Use, Nutrients, And Aquatic Communities In Headwater Streams

Danielle Braund
Faculty Mentor: Sally Entrekin

Global hypoxic zones have doubled in area every decade since the 1960s from excessive nutrient inputs. Increased nutrients cause spikes in primary production and heterophic respiration that lead to a depletion in dissolved oxygen and eventual anoxia. Excess nutrients come from point- and nonpoint-source inputs mostly associated with agriculture. The Mississippi River Basin (MSRB) supports the second largest hypoxic zone in the world, spanning 21,000 square kilometers at the mouth of the MSR. The Lake Conway Point Remove watershed (LCPR) was ranked in the top 150 watersheds for the phosphorus exported by streams to the MSR. The origin of this excess phosphorus and its effects on biogeochemical processes and aquatic communities within streams is unclear. Measuring alkaline phosphatase activity (APA), sediment-equilibrium phosphorus concentrations (EPC), and macroinvertebrate community assemblages in 5 agriculturally-dominated and 5 forested watersheds will enhance our understanding of how phosphorus is transformed and transported in stream systems. We predict that phosphorus and nitrogen concentrations will be greater in watersheds with >50% pasture than watersheds that are more forested. Therefore, EPC will be higher in watersheds that contain more pasture. APA will be lower in watersheds that contain more pasture due to higher phosphorus concentrations. Macroinvertebrate richness is expected to be lower in watersheds with >50% pasture due to the sensitivity of certain species to changes in water chemistry and increased nutrient concentrations. By understanding the origin, transport, and assimilation patterns of phosphorus, local and regional sources and consequences of excessive nutrients higher in the watershed can be identified and reduced prior to reaching a lower river system.

Diel Patterns in Riffle Species Diversity in the King's River, Arkansas

Jacob Colbert, William Glenn, Chance Garrett
Faculty Mentors: Reid Adams, Ginny Adams

Understanding demographics of benthic fishes within riffle habitats during both day and night can offer insight on mating, spawning, movement, and feeding patterns. Little research has been conducted on the diel movements of fishes in upland rivers, partly due to the logistics of sampling. Studying temporal fish use of riffles will aid our understanding of how species use these highly productive feeding areas differently with time-of-day. Fishes were sampled in 11 riffles, during both day and night, along a 6.9-km reach of the lower Kings River during August and September, 2017. Riffles were thoroughly sampled with numerous kick-sets using a seine. Several species of benthic and pelagic fishes (e.g. *Noturus albater*, *Etheostoma euzonum* and *Fundulus catenatus*) were sampled in higher abundances during the night sample in comparison to daytime. Noturus albater was selected for diet analysis due to its diel variation in riffle habitat use. We quantified stomach fullness, level of digestion and identified prey items for specimens collected during the day compared to night. Preliminary results displayed widely varying feeding habits, as the nighttime specimens' stomachs were often filled to bursting and the day specimens' commonly empty. Differences in both dietary factors and species composition relative to sample times within the riffles may be explained through predator evasion, prey availability, and interspecific competition. Knowledge of diel movements exhibited by these benthic species can provide understanding of the effects of erosive flooding on riffle habitats, as well as future insight on conservation/restoration efforts in freshwater streams and rivers. Additionally, fish surveys based on daytime sampling only could be biased, and understanding these biases is important.

Morphological Evolution of Fish Caused by Changing Stream Habitats

Walker Culp
Faculty mentor: Ginny Adams

Fish shape is known to exhibit both phenotypic plasticity and a rapid response to alterations in habitat. Most research on fish shape change has examined the impact of habitat alteration from a lotic to lentic system after construction of dams. In the White River watershed in north Arkansas, the Kings River flows directly into Table Rock Dam, potentially isolating lotic fishes. We are investigating how this potential barrier to movement (Table Rock Dam) could potentially affect morphology of fish species in this watershed. We were specifically interested in the morphology of *Lepomis megalotis*, *Lepomis macrochirus*, and *Notropis greenei* as these species were noted as looking superficially different in the Kings River. Although current studies on anthropogenic alteration to aquatic habitats in Arkansas have shown community level responses, no research has been done on individual fish morphology. Photographs of the target species were digitally landmarked with TPS software and morphometric data analysis was conducted using the R program suite. The MANOVA statistical analysis done on the geometric coordinates proved significant results in the variance between the populations separated by the dam. On average, *L. megalotis* showed the least amount of variation and *N. greenei* had the highest variance factor. The predominant changes in the greenei were shortening of body length with slightly taller body height seen in the subjects from the King's. *L. macrochirus* samples from the Kings had a signifcantly shorter body length as well, but there was little change in specific fin dimensions as previously expected. This shorter body length may have arisen from the decreased flow current caused by the dam, but further studies need to be done to provide sufficient evidence as to the reason why.

Characterization of the 1918 influenza pandemic in Missouri and Arkansas

Adam Davidson, Anna Blach, Maison Mitchell, Kaitlyn Kemp, Abigail Galicia-Romero, Martha Kabengele, Laura Lin, Harleigh Robbins
Faculty Mentor: Ben Rowley

The 1918 influenza pandemic is considered to be one of the worst influenza pandemics in history. Approximately 20-50 million people died worldwide, with approximately 600,000 of those deaths occurring in the United States. Many studies have examined this pandemic, but most have focused on large urban centers such as New York City and San Francisco. Much less is known about how the disease manifested in less-populated and more agricultural areas of the country. This study examines death records for Arkansas and Missouri from September 1918 to April 1919, characterizing the age-distribution of those who died from the illness in each state. Individual death records for the years 1918 and 1919 for each state were examined, with deaths attributed to influenza recorded for basic demographic information, including date of death, age at death, gender, location of death, and primary/secondary causes of death. Comparisons to expected death numbers for different age groups based on national 1918 pandemic death trends are examined utilizing a chi-squared test. Gender differences in mortality rates are also examined and compared to national trends for the 1918 pandemic. Finally, geographic distribution of deaths over the 8 month time period of the pandemic are examined for each state on a county-by-county basis utilizing ArcGIS software, illustrating how the disease spread through the states over time. These analyses and comparisons against national death rates and trends will shed new light on how the pandemic played out in rural and agricultural areas of the country.

Host Specificity of the *Burkholderia – D. discoideum*: Artificial and natural *Burkholderia* infections in *D. purpureum* and *D. giganteum*

Mercedes Dillard
Faculty Mentor: Tammy Haselkorn

Symbiosis is the interaction between two different organisms living in close association, usually to the advantage of both organisms. Symbiosis may be essential for some organisms and therefore essential to the ecosystem. Symbionts that have long lived with their hosts may be beneficial and completely dependent on vertical transmission, losing the ability to infect other hosts. Bacterial symbionts that have recently infected hosts may retain the ability to infect novel hosts, and may still retain pathogenic tendencies. We used the recently discovered symbiotic interaction between the bacteria *Burkholderia* and its natural amoeba host *Dictyostelium discoideum* (*Dicty*), to explore how long lived this association is. To test the host specificity of the different *Dicty-Burkholderia*, we artificially infected two other species of amoeba, *D. purpureum* and *D. giganteum*, with six different strains (3 from two different groups, B1 and B2) of *Dicty-Burkholderia*. Spores of each species were plated with the different strains, allowed to grow and form fruiting bodies, and then tested for bacterial infection by spotting the fruiting bodies on a new plate. We then conducted a DNA extraction in order to verify the presence of *Burkholderia*. Due to its smaller genome indicating rapid evolution and long-term coevolution inside a host, we hypothesize that the B2 *Burkholderia* strains will have lost the ability to infect other species of amoebae, while the B1 *Burkholderia* strains will still be able to infect other species. Based on the results, neither clade is more host-specific than the other as most *Burkholderia* strains were able to infect both species. Additionally, we screened local populations of *D. purpureum* and *D. giganteum*, and discovered additional strains of *Burkholderia* symbionts, suggesting that many different types of *Burkholderia* can be symbionts of amoeba.

Effect Of Pregnenolone Availability And 3ß-Hydroxysteroid Dehydrogenase HSD-3 On Dietary Restriction-Mediated Stress Resistance In *C. Elegans*

Justin Dino
Faculty Mentor: Mindy Farris

Dietary Restriction (DR) has been shown to increase the stress resistance of *C. elegans* through independent and overlapping hormone signaling pathways. A deletion mutant of eat-2 confers a genetic model of DR that reduces pharyngeal pumping and increases day-1 adults' resistance to heat stress when compared to wild-type N2. 3β-hydroxysteroid dehydrogenases HSD-2 and HSD-3, orthologous to 3β-HSDs found in vertebrates, have also been identified in *C. elegans*, which enable examining DR-mediated stress resistance in different environmental conditions. A deletion mutant of hsd-3 increases stress resistance in bacterially-deprived (BD) conditions. However, a double mutation in eat-2;hsd-3 reduces stress resistance when nutrients are available. Steroid precursor pregnenolone (PREG) was fed to eat-2, hsd-3, eat-2;hsd-3, and N2 to assess its ability to rescue the eat-2-mediated phenotype. eat-2;hsd-3 with PREG was hypothesized to have greater stress resistance than eat-2;hsd-3 control; specifically, it should have stress resistance similar to eat-2 control. hsd-3 fed with PREG was hypothesized to have stress resistance similar to N2 control if PREG is the precursor used by HSD-2/HSD-3. Differences between the control and PREG treatments for all strains were statistically insignificant although there were several notable trends: N2 with PREG showed greater stress resistance than N2 control; however, stress resistance for hsd-3 in both conditions were similar. Furthermore, we found that PREG slightly increased eat-2;hsd-3 stress resistance compared to eat-2;hsd-3 control but not to the extent of the eat-2 control. hsd-3 with PREG and N2 showed similar stress resistance, but further trials are needed for a more accurate comparison. It is still possible that PREG is the precursor steroid needed by HSD-2/HSD-3 to make the hormone that induces stress resistance but that a functional enzyme is required to synthesize the PREG-derivative. Gas chromatography mass spectrometry analysis would allow for identification and analysis of hormone concentrations for each strain.

Does Western Spruce Budworm Herbivory Alter Macroinvertebrate Community Composition And Stream Food-Web Dynamics?

Deion Everhart
Faculty Mentors: Sally Entrekin, Clay Arango

In the Pacific Northwest, herbivorous Western Spruce Budworm (WSB) outbreaks have increased intensity and extent along Douglas-fir forest riparian areas. As headwaters rely on riparian energy and nutrient subsidies, WSB outbreaks could increase headwater stream resources. We hypothesized that frass inputs from WSB herbivory would directly elevate stream resources and solar radiation via canopy defoliation. We predicted higher diversity in headwater streams with high herbivory from more heterogeneous food resources. We also predicted greater total macroinvertebrate density and more collectors from increased energy and nutrient inputs in headwaters exposed to high WSB herbivory. Macroinvertebrate communities were compared between headwater streams with low (n=4) and high (n=4) WSB herbivory. We found total density was greater in high WSB herbivory sites, but contrary to our prediction, diversity was greater in the low WSB herbivory sites. Increased shredder and scraper densities in high WSB herbivory sites may be from added frass as a food resource. Additional stable isotopic analysis of food resources are needed to determine contribution of frass to macroinvertebrates. Our results will quantify the effects of herbivorous WSB outbreaks on community composition and stream food-web interactions.

Serial Founder Effects In Crotaphytus Collaris: The Influence Of Genetic Drift On Phenotypic Diversification

Andrew Feltmann
Faculty Mentor: Matthew Gifford

Founder effects have been proposed as an important mechanism driving evolutionary divergence among populations, and even speciation. These events are normally a result of colonization of new habitat patches by a small number of individuals resulting in a change in the genetic and phenotypic constitution of a population. Empirical evidence suggests that genetic drift and selection interact in complex ways influencing, and that the signatures of drift can persist despite selection favoring different phenotypes. Overall, clear experimental evidence of the phenotypic responses to founder effects is scarce in the literature because documenting rare colonization events and their timing is very difficult. We will use a rare instance where the timing of founder events is known to assess the relative effects that drift, and potentially selection has had on phenotype distributions in a population of Collared lizards (*Crotaphytus collaris*) on a set of nearby mountains in South-Central Missouri. Data indicate that the population initially reintroduced on one mountain serially dispersed onto two other mountains. I will quantify a suite of phenotypic traits including morphology and physiology to test for differential signatures of genetic grift and natural selection. These data will directly address a classical question in evolutionary biology, namely, how do drift and selection interact to drive phenotypic diversification?

Habitat Associations Of Riffle Fishes In An Ozark River Having A Dynamic Gravel Bed Load

Chance Garrett
Faculty Mentors: Ginny Adams, Reid Adams

Streams of the Arkansas Ozarks have experienced extensive erosion and gravel intrusion due to changing land use. As a result, modifications to instream habitat have resulted in an increase in transverse and diagonal gravel bars along with associated shallow, low flow riffles. This study was conducted to determine if variation in riffle habitat (depth, velocity, substrate size) affects riffle fish communities. Understanding how fishes are using different riffle habitats is crucial to ensuring restoration efforts provide the necessary habitats for fishes throughout their various life history stages. For this study 22 riffles were sampled in the Kings River, Arkansas using seines and kick set methods. Fishes were preserved in 10% formalin and identified in lab; standard lengths of benthic fishes were taken. Habitat data were collected at each riffle including velocity, pebble count, depth, and water quality. The King's River exhibited a gradient in available riffle habitat with two extremes being shallower, slower, wider riffles with smaller substrate (unstable riffles) and deeper, faster, narrower riffles with larger substrate (stable riffles). Benthic species richness was greater in stable riffles. Two species, *Etheostoma zonale* and *Noturus albater*, were found at different lengths in the two riffle types. *Etheostoma zonale* were found to be larger in stable riffles and *Noturus albater* were found to be larger in unstable riffles.

Glucose Availability Impacts Proteotoxic Stress

Landon Gatrell
Faculty Mentor: Mindy Farris

Alterations in protein folding may lead to aggregation of misfolded proteins, ultimately leading to toxicity and cell death. Protein aggregation has been shown as a normal consequence of aging, but it is largely associated with age-related disease, particularly neurodegenerative diseases like Alzheimer Disease (AD) and Huntington Disease (HD). Under normal circumstances, glucose enrichment shortens the lifespan of the model organism Caenorhabditis elegans; however, recent research suggests that glucose enrichment actually provides some protection against cell stress, including proteotoxicity. Huntington Disease is a useful model for neurodegenerative research, as it is strictly genetic and caused by mutation of a single gene. We are investigating glucose-mediated neuroprotection against Huntington Disease models of the nematode *Caenorhabidits elegans*.

Our results show that NGM plates with 250mM glucose are not sufficient to provide a protective, lifespan extending effect in the AM101 strain of *C. elegans*, where the polyglutamine repeat (the causal mutation in HD) is expressed in the neurons. Furthermore, we show no difference in motility across three different polyglutamine strains of *C. elegans* (AM101, AM138, AM140), with or without glucose, when compared to the wildtype. These data suggest that the polyglutamine construct and the addition of glucose have no effect on these phenotypes or functions, contrasting other results. Interestingly, the AM141 strain, where polyglutamine is expressed in body wall muscles, does show a decrease in motility and this seems to be exacerbated with glucose addition, contrary to our expectations. We plan to continue to investigate lifespan, motility, reproduction, enzymatic activity, and protein expression of *C. elegans*.

Neurodegenerative diseases represent a significant threat to national health and healthcare expenses. By understanding the mechanisms behind glucose-mediated neuroprotection, we can begin to understand the underlying toxic factors present in HD, which are currently unknown, and potentially isolate target areas for treatment of HD.

Comparative Genomics And Host Specificity Of The *Burkholderia* Bacterial Symbionts Of The Social Amoeba *Dictyostelium discoideum*

Frank Griffin
Faculty Mentor: Tammy Haselkorn

Symbiotic interactions include a range of relationships between different organisms, including mutualistic ones, such as nutrient provisioning or providing defense against parasites, as well as harmful relationships that involve parasitism. *Dictyostelium discoideum* (*Dicty*) is a soil-dwelling single-celled amoeba that feeds on bacteria in nature and is an ideal model organism to study host-symbiont interactions. The genus *Burkholderia* contains a diverse group of bacteria that have a wide range of lifestyles, including *D. discoideum* symbionts. There are two different types of strains of *Dicty-Burkholderia* that have been found in nature: B1 and B2. Both types of *Burkholderia* have a unique symbiosis with *D. discoideum* that allows the amoeba to farm its own bacteria. The B1 clade bacteria generally have a larger genome of ~9Mb, while the B2 clade strains have a smaller genome of about 4Mb. If this smaller genome size is a result of long-term coevolution with the host, it may have lost the ability to infect a novel host, whereas B1 may be less host-specific and maintain that ability. We used four different strains (2 from each clade) of *Dicty-Burkholderia* to infect three different *Dictyostelium* species, *D. giganteum*, *D. mucuroides*, and *D. purpureum*. We grew these different amoeba species on plates with *Burkholderia*, allowing fruiting bodies to develop, and used presence of bacteria growth when fruiting bodies were spotted on new plates to measure *Burkholderia* infection success. The B2 strains had bacteria present across all three species. One of the B1 strains had the most negatives across all species. Fruiting body growth on spot tests could be an indication that the DF-*Burkholderia* successfully infected our social amoeba host, and the farming trait allowed spores to survive. Thus, despite vastly different genome sizes, both types of *Burkholderia* were generally able to infect new species.

The Effect Of Simulated Microgravity On The Biophysical Properties Of The Tibia

Kristen Jones, William Fuell
Faculty Mentors: Rahul Mehta, Brent Hill

Simulated microgravity has been linked to a decrease in bone density and strength. Because most bone density studies have utilizing the male sex, challenges may exist if spaceflight is not also investigated in the female sex. Our lab has previously shown that estrogen depletion leads to a decreased bone density and volume. The objective of this study is to determine the effects of microgravity on the biophysical properties of the tibial bone in female mice. Female mice (4-month old) underwent an overiectomy (OVX, n=7) or SHAM (n=8) surgery. They were then suspended in a harness to simulate weightlessness in their hindlimbs (HLU). Food and water intake ($p>0.05$) was monitored throughout the HLU period. After 3-weeks of HLU, the mice were sacrificed. Plasma estrogen (E2), plasma corticosterone (CORT), uterine weight, and body weight was measured. The body weight was similar between groups. The OVX uteri (31±0.10 mg) was less than the SHAM group (81 ±16 mg); however, the plasma E2 and CORT levels were the same. We are currently using three-point bending to quantify the mechanical properties (breaking point, stress, stiffness, and elasticity) of the tibia. Preliminary data indicates the breaking point for OVX (n=5) and SHAM (n=5) mice to occurs at 6.55±0.79 N and 7.43±0.65 N, respectively. This study will provide baseline data about the female sex and circulating estrogen so the effectiveness of countermeasures can be evaluated in the future.

A Retrospective Multistate Analysis Of Influenza Pandemic Deaths

Spencer Long, Ashton Purtle
Faculty Mentor: Ben Rowley

The 1918-1919 H1N1 influenza pandemic was one of the deadliest in modern history. Es+mates of 600,000 US deaths and as many as 50-100 million deaths globally are common. The pandemic raged in the US from September 1918 through April 1919. While a variety of studies have examined death trends for the pandemic at the large city (e.g. New York City) or na+onal level, far fewer studies have been performed on individual states without large urban centers. This project examines the pandemic in New Hampshire, Arkansas, and Arizona. Each of these states represents a very different part of the country – long-established New England, rural-agricultural mid-South, and Southwest deserts and mountains. Age and gender demographics in the pandemic mortali+es are collected from death record archives and tested against expected values obtained from federal census information. A full breakdown of age of death information in each state's population is included. This work represents new information regarding the 1918 pandemic in as-yet unexamined geographic areas.

Change In Historic Vs Contemporary Fish Assemblages Of The Strawberry River, Arkansas

Jennifer Main
Faculty Mentors: Ginny Adams, Reid Adams

The Strawberry River is the most diverse river in Arkansas with 107 documented species and is a priority watershed to the state of Arkansas. The Strawberry River is a tributary to the Black River, located in the Salem Plateau of the Ozark Highland and Mississippi Alluvial Plain. The poultry industry has experienced the most rapid growth in north Arkansas, including the Strawberry River watershed. Approximately 60% of this watershed is forest and 29% pasture. This watershed is of big concern due to the increasing poultry industry and the potential impact that poultry could have on the diversity of fishes in the watershed. Historical fish assemblage data from 9 sites was compared to contemporary data (2017) to determine if land use change is affecting the fish communities of the Strawberry River. A total of 9,659 individuals representing 67 species were collected across the 9 sites both contemporary and historical. 63 were collected in 2017 and 48 historically. Species relative abundance was compared between time periods with a nonmetric multidimensional scaling (NMDS), 2-dimensional. There was no significant difference between historic and contemporary fish assemblages (MRPP p=0.642) based on Bray-Curtis. Stability and persistence will be determined for the 9 sites.

Determination of Endangered Bat Species' Use of Artificial Bark-Enhanced Habitat in North Central Arkansas

Sarah Martin
Faculty Mentor: Vickie McDonald

Bats play an important role in shaping our ecosystem, yet despite this there is little known on their populations and distribution in Arkansas. Impending threats to regional bat populations from white-nose syndrome (WNS), climate change, and habitat loss has concerned federal and state wildlife agencies, as well as other natural resource entities. My project is to test whether Arkansas bats in general, and specifically whether endangered bats, such as the Indiana bat (*Myotis sodalis*), will utilize artificial bark applied to utility poles as an effort to mitigate habitat loss. I have just erected poles covered by the bark at three sites in northern Arkansas, and one site in the Arkansas River Valley. Currently no Arkansas research exists on whether bats will use artificial bark (BrandenBark brand) applied as sheets to large utility poles or stripped trees for potential colony nests or roosting. The BrandenBark artificial bark was created by Copperhead Environmental Consulting with the intent to help mitigate habitat loss for bark roosting bat species; thus far it has had limited pilot research. My research will be the first controlled study using large sample sizes on the feasibility of artificial bark for enhancing the habitat for Indiana bats Arkansas.

Host Specificity of *Burkholderia-Dictyostelium discoideum* Symbiont and Identification of *Burkholderia* Symbionts from other Social Amoeba Species

Alexandria Melton
Faculty Mentor: Tammy Haselkorn

Symbiosis can be observed diversely across eukaryotic life, impacting the health, ecology, and evolution of both host and symbiont. The relationship identified between the soil-dwelling amoeba, *Dictyostelium discoideum* (*Dicty*) and its bacterial symbiont, *Burkholderia* can serve as a model to help gain insight on these complex symbiotic interactions. Strains of two *Burkholderia* phylogenetic clades (B1 and B2) are capable of withstanding amoeba digestion and confer "farming" in the amoeba; in other words, *Burkholderia* infection enables the *Dicty* to have the capacity to carry bacteria in their spores, and in the event of landing in a foodless environment, they can grow their own bacterial food, proving to be advantageous to the amoeba. The goal of our research is to explore the host specificity of these bacterial symbionts, hypothesizing that B2 *Burkholderia* are more host-specific than B1 *Burkholderia*. Furthermore, B2 *Burkholderia* will have lost the ability to infect other species of amoebae, whereas B1 strains will be capable of infecting other species. We have extended our research to other amoeba species, *D. violaceum* and *D. mucoroides*. Spores from these species were collected and grown with each of six different *Burkholderia* strains, and infections were assessed by 'spotting' fruiting bodies on a new plate and looking for bacterial growth. Results of the spot tests did not support the hypothesis. Both *Burkholderia* clades yielded positive spot tests with both experimental species indicating that strains from both clades have the capacity to infect not only *D. discoideum*, but also other closely related amoeba species. To further our experiment, PCRs were performed on DNA extracted from amoeba from local soil samples, using *Burkholderia*-specific primer sets. *Burkholderia* has been detected in a subset of the samples, and we are sequencing them to give accurate identification of amoeba species and present symbiont bacteria.

Is The Leafy Gene A Single Copy Gene? A Test In The Asteraceae Tribe Astereae

Miguel Mercado
Faculty Mentor: Richard Noyes

The tribe Astereae of the sunflower family (Asteraceae) is predominantly North American in distribution and includes the familiar goldenrod and aster genera, among many others. Evolutionary relationships for the group are poorly resolved; however, the nuclear gene Leafy (LFY) has successfully been used in some plant groups (Lu et. al., 2012). It is a single copy gene consisting of 3 exons and 2 introns. Previous research done in our lab made use of exon 1 of the LFY gene for 12 different species, and yielded some degree of success. This experiment seeks to expand on our past research by making use of exon 3 for the same 12 species and 2 additional outgroup species. The results suggest that LFY may be present in more than one copy, possibly as a result of whole genome duplication prior to the origin of the Astereae tribe. Future analyses will have to carefully take in to account two or more paralogous copies of LFY.

Sub-Lethal Ion Concentrations Alter Shredder Performance And Leaf Litter Processing

Anastasia Mogilevski
Faculty Mentors: Sally Entrekin

Streams in the Arkansas Valley have naturally low ion concentrations (~30 µS/cm). However, ion concentrations are increasing because of agriculture, wastewater effluent, and resource extraction (1.26-533 mg/L Cl-). The state only regulates chloride ions despite the rise of other major ions (e.g. Na+, Mg2+, Cl-, K+, HCO3-), and ion-specific biological effects are largely unknown. Conductivities above naturally occurring ion concentrations could induce sub-lethal effects in aquatic organisms. Sub-lethal ion concentrations may slow leaf litter processing via reduced detritivore feeding or growth. We predict sub-lethal salt concentrations may change litter-processing rates by altering the energy required by microbes and shredders for osmoregulation, and by altering litter quality for shredders. Here, we predict salt-induced changes in microbial community composition and activity will decrease processing rates by reducing shredder litter palatability or nutrition. Isopods, a crustacean, were fed leaves incubated in natural streamwater (~3 mg/L NaCl), and leaves incubated in one of six NaCl or NaHCO3 treatments (16, 32, 64 mg/L). Isopods grew ~20% less in the intermediate salt concentrations compared with natural streamwater. The rate of respiration and amount that isopods ate did not differ between natural and intermediate salt concentrations. Therefore, we predict insect shredder growth will also decrease from altered nutrition when fed salt-incubated leaves using the same salt treatments as above with a common shredding caddisfly. Results will further support that sub-lethal salt concentrations can indirectly alter stream detrital processing.

The Growth Of Glyphosate-Resistant *Amaranthus palmeri* In Response To Increased Temperature And Water Stress

Hannah Parks
Faculty Mentors: Richard Noyes

Glyphosate, the active ingredient in Roundup®, is a versatile, nonselective herbicide. Agricultural systems became over-reliant on glyphosate following the introduction of crops genetically-modified to resist glyphosate in 1996. A lack of diversified weed-management strategies and increase in glyphosate application created a strong selective pressure that led to the evolution of glyphosate-resistant weeds. Glyphosate-resistant *Amaranthus palmeri* has become one of the most troublesome weeds in Arkansas agricultural systems, making it important to study the effects the trait might incur on plant competiveness. As environmental conditions change, weed population dynamics will shift, and understanding the effect that these conditions impose on weed growth is vital for weed management and agricultural sustainability. This study examined glyphosate-resistant *A. palmeri* growth under drought stress and increased temperature by comparing the growth of three resistant Arkansas populations to two susceptible populations. We hypothesized that the glyphosate-resistance trait would incur a fitness cost, and therefore, the glyphosate-resistant populations will not grow as tall as the susceptible populations. A shikimic acid leaf disc assay was used to confirm the glyphosate resistance and susceptibility of the respective populations. Plant height was compared between glyphosate-susceptible and glyphosate-resistant *A. palmeri* plants grown at 40ºC/35ºC and 35ºC/30ºC, and between plants exposed to five days of drought stress and zero days of drought stress. The results reveal that glyphosate-resistant *Amaranthus palmeri* populations do not grow as tall as susceptible populations across treatments. This data supports the idea that in the absence of glyphosate, glyphosate-susceptible *A. palmeri* could outperform glyphosate-resistant *A. palmeri*. Further testing on photosynthetic and reproductive traits is needed before strong conclusions can be made about the fitness of glyphosate-resistant *Amaranthus palmeri* in the absence of glyphosate.

Cellular scaling in brain of the nine-banded armadillo (*Dasypus novemcinctus*)

Nicole Poling
Faculty Mentor: Jeffrey Padberg

The distribution of neurons and non-neurons in mammalian brain structures varies across species. The cellular distributions of mammalian brains have been widely studied, but quantitative examination of cellular composition of xenarthran species has not been described. In this study, we used isotropic fractionation to determine the number of neuronal and non-neuronal cells in the nine-banded armadillo, *Dasypus novemcinctus*. The right and left sides of each structure were processed separately. Cellular nuclei were identified by staining with 4',6'-diamidino-2-phenylindole (DAPI), and all neuronal nuclei were identified by immunocytochemistry for the neuronal nuclear antigen (NeuN). Neuronal nuclei were secondarily stained with AlexaFluor 555 or 594 for visualization. Here we present the first quantification for neuronal and non-neuronal cell counts for the armadillo brain. The armadillos used in this study had body masses ranging from 5.0-6.1 kg and brain masses ranging from 10.7-13.9g. We observed that the armadillo brain ranges from 36-44.1 million non-neuronal and 4 million neuronal cells in the cortex, 49-55.7 million non-neuronal and 4.8-5.6 million neuronal cells in the pyriform cortex, and 15.5-33.5 million non-neuronal and 3-5 million neuronal cells in the hippocampus. Based on these results, the cortex is 9-10% neurons, the pyriform cortex is 8-10% neurons, and the hippocampus is 14-18% neurons. The neuron densities in these structures ranged from 1.2-1.9 million neurons per gram in the cortex, 1.8-1.9 million neurons per gram in the pyriform cortex, and 4.8-6 million neurons per gram in the hippocampus. With these data, we can add xenarthrans to the large number of species whose brain cellular compositions have been previously studied. Studying the cellular distribution of the armadillo brain not only provides insight into the brain structure and function of a xenarthran species, but also enhances our understanding of cellular scaling rules across mammalian clades and the evolution of brain structures in general.

Comparison Of Antimicrobial Properties Of Different Beer Brewing Methods

Harleigh Robbins
Faculty Mentor: Benjamin Rowley

Beer brewing methods may result in contamination with a variety of different microbes, from the environment, implements used in the brewing process, or from the normal microbiota of the brewers themselves. Modern brewing techniques utilize the herb Humulus lupulus, or hops, for taste profiles and preservative/antimicrobial measures. These herbs are added into the brewing process before yeast is added to the mixture. The yeast then allows for fermentation and alcohol production. But brewing methods from earlier times utilized a variety of herbs other than hops for a similar purpose. Some of these herbs include elder flowers, sweet gale, and mugwort. These herbs were often mixed together in a combination generally known as gruit that was then used in the brewing process. The purpose of this study is to compare the antimicrobial properties of unfermented beer produced with hops versus an unfermented beer product produced with gruit. Disc-based antimicrobial susceptibility testing of the brewed products will be assessed for both recipes. Antimicrobial testing results of the gruit recipe will be compared against the results obtained for the modern hops-based recipe using a Student's T-test ($p<0.05$) to determine if the non-hops recipe is significantly better (or worse) as a preservative/antimicrobial than hops. A Gram-positive bacterium, Gram-negative bacterium, and fungal microbe will each be assessed for susceptibility to the unfermented brew from each recipe.

Characterization of Biomass Smoke Particles via Scanning Electron Microscopy and Energy-Dispersive X-Ray Spectroscopy

Mason Rostollan
Faculty Mentor: Leah Horton

The burning of biofuels for cooking and heating is particularly common in regions with low socioeconomic status and can lead to detrimental respiratory illness or mortality. This problem is worsened by lack of affordable healthcare and poor environmental health conditions. Previous work in Kanembwe, Rwanda has identified smoke production as an area of concern with respect to health. The World Health Organization (WHO) recognizes particles with an aerodynamic diameter of 10 μm (PM10) or less is considered inhalable, and below 2.5 μm (PM2.5) is considered a fine particle and has a more devastating effect on respiratory health However, the use of rocket stoves may be able to lower the negative health impacts by reducing smoke production. Verbal accords suggest a reduction of irritation to both eyes and lungs. In this study, we will first use a Sioutas personal cascade impactor sampler (PCIS) to collect suspended particulates from both a traditional 3-stone fire and an implemented rocket stove. Once the particulates are collected, we will characterize the size, shape, and elemental composition of smoke particles via scanning electron microscopy (SEM) and energy-dispersive x-ray spectroscopy (EDS). Preliminary data was collected using a rocket stove at the university before field tests in Rwanda. These preliminary tests show large numbers of fine particles being released into the air and collected with the PCIS, with slightly varying compositions consisting of C, O, Mg, Mn, Ca, Nb, and F. Future work will include field tests in Kanembwe, comparisons between the two cooking methods, and daily personal exposure experiments. The identification of these characteristics are essential to understanding the potential health risks of biomass fuel burning.

Bryophyte Diversity Of Arkansas

Shelby Ruple
Faculty Mentor: Richard Noyes

Bryophytes are a diverse group of land plants that comprise approximately 20,000 species and are divided into three main divisions: Marchantiophyta (liverworts), Anthocerotophyta (hornworts), and Bryophyta (mosses). Bryophytes are found worldwide, but the highest level of bryophyte diversity is found in tropical and temperate regions. Diversity of bryophytes in Arkansas is poorly known because a large-scale accounting of bryophyte diversity for Arkansas is lacking. The Ozark region has been sampled much more extensively than other regions of the state, such as the Arkansas River Valley or the Ouachita Mountains. There are approximately 376 known bryophyte species in Arkansas, which include 254 species of mosses, 115 species of liverworts, and 7 species of hornworts. However, this total is likely an underestimate of the actual bryophyte diversity in Arkansas. In addition to organismal diversity, population level studies help to gain a better understanding of how these plant populations are influenced genetically by sexual and asexual reproduction. In this study three markers, rcbL, trnL-F, and nuclear ITS, will be used to examine the gene flow between 12 populations of a native leafy liverwort, Frullania inflata. The objective of this research is to characterize the bryophyte flora in Cove Creek Natural Area and understand the genetic structure of several populations of *Frullania inflata*.

The Effects of Microgravity on the Vascular Tone in Female Mice

Sage Shaddox
Faculty Mentor: Brent Hill

Microgravity has been previously demonstrated to reduce vascular tone in male mice. However, few studies have evaluated the effect of microgravity on vascular function in female mice. Simulated microgravity was induced for 4 weeks using tail-ring, hind limb unloading (HLU) in female mice (4 months old). We hypothesized that removal of gonadal estrogen via an ovariectomy (OVX) would exacerbate the aortic contractile response in HLU mice. We tested four treatment groups of mice: (1) SHAM ground/non-HLU, (2) SHAM HLU, (3) OVX ground/non-HLU, and (4) OVX HLU. Isometric tension measurements were determined in response to the Ca2+ channel agonist, FPL64126, and the α1-adrenergic agonist, phenylephrine, and the Ca2+ channel antagonist, nifedipine. Our results suggest that OVX HLU mice have a greater aortic contractility to phenylephrine, but not FPL64126; thus, suggesting an enhanced SR Ca2+ release mechanism. There was a decline in body weight due to the HLU treatment in both groups of mice; however, the daily food and water consumption was similar. Using magnetic resonance imaging, fat and lean mass were measured in all groups. With OVX mice, HLU treatment induced less fat accumulation than the ground mice. Also, the OVX mice lost lean mass. Plasma corticosterone was elevated in HLU mice compared to the ground mice. This study provides foundational knowledge about how microgravity may exacerbate vasoconstriction, and limit energy reserves (fat accumulation) in female mice with reduced gonadal estrogen production. Thus, impacting potential countermeasures for female astronauts entering peri-menopause or menopause. Support: Arkansas Space Grant Consortium & UCA Student Research Funds.

Organization Of The Retinofugal Pathway And The Visual Thalamus In The Nine-Banded Armadillo (*Dasypus Novemcinctus*)

Brooke Skinner
Faculty Mentor: Jeff Padberg

Previous research has shown that animals with forward facing eyes, such as predators and primates, exhibit partial crossing over of the retinofugal pathways at the optic chiasm. In contrast, animals with laterally positioned eyes, such as rodents, exhibit almost exclusively crossed pathways; the retinal pathways terminate overwhelmingly on contralateral thalamic nuclei. The aim of the current study was to determine the organization of retinofugal pathways in the nine-banded armadillo (*Dasypus novemcinctus*), a member of the Xenarthra superorder and the only species of armadillo found in North America. Extant xenarthrans lack cone photoreceptors, and it has been suggested that stem xenarthrans became rod monochromats, in conjunction with a fossorial lifestyle. Based on their relatively lateral eye position, we predicted that the retinofugal pathways would exhibit nearly exclusively contralateral projection. Intraocular injections consisting of twenty microliters of fluorescent anterograde tracer (.5-1% WGA+CTB Alexa-Fluor 555 with 2% DMSO in the left eye and .5-1% WGA+CTB Alexa-Fluor 488 with 2% DMSO in the right) were placed into the vitreous humor of the eyes of armadillos. Cytoarchitectural stains such as Nissl and cytochrome oxidase (CO) histochemistry, along with immunocytochemical techniques using antibodies to calbindin, parvalbumin, and nonphosphorylated neurofilament protein, were used to identify the thalamic nuclei. The dorsal and ventral divisions of the lateral geniculate nucleus (LGN) stained intensely for CO, with a thin intrageniculate leaflet separating the two. Tracer label was observed contralaterally in both the dorsal and ventral divisions LGN and in the most superficial layer of the superior colliculus. An area within the dorsal portion of the contralateral LGN was filled with ipsilateral label, which is indicative of the recipient zone of projections from the ipsilateral eye. This overall pattern resembles the organization found in marsupials and eutherian mammals with laterally placed eyes, and thus, it is likely that armadillo vision is predominantly monocular. Future functional studies are likely to reveal the extent to which a frontal binocular field, if any, is present in this species.

Migration Dynamics of Ohio Shrimp, *Macrobrachium ohione*, in the Lower Mississippi River

Geoffry Spooner
Faculty Mentor: Reid Adams

The Ohio shrimp is amphidromous, serving as a trophic link between the Gulf of Mexico and inland reaches of coastal plain rivers. Ohio shrimp feed primarily on basal food resources, transferring energy to fish predators within rivers. Current distribution, abundance, and life history of Ohio shrimp are relatively unknown upriver of Louisiana. Historical range of Ohio shrimp included the Ohio River and Upper Mississippi River, but abundance upriver of Louisiana has reportedly declined. We collected shrimp monthly from March 2016 through November 2016 with wire-meshed traps deployed along the mainstem Mississippi River and Lower Arkansas, White, and St. Francis rivers. Total catch increased in May (150 shrimp), peaked in June (2,080 shrimp), and declined from August (1,814 shrimp) to November (13 shrimp). A total of 6,984 Ohio shrimp were collected and 5,090 of those individuals were classified as juveniles. Males ranged in size from 3.8 to 18.3 mm carapace length and females ranged from 4.0 to 23.0 mm carapace length. Adult sex-ratio was male-skewed in May - June and 1:1 in the following months, but juvenile sex-ratio was female-skewed throughout the peak migration period. Relatively fewer adult females in traps during spring was possibly a result of downriver movement, indicative of an amphidromous life history. A total of 22 ovigerous females, females that are carrying eggs in the pleopods, were collected from the standard trapping locations and 19 of those females were trapped at Mississippi River locations. The majority were collected between June and July, which is the peak of the reproductive period for Ohio shrimp. Despite declines from historic densities, Ohio shrimp likely remain important components of food webs in the Arkansas reach of the lower Mississippi River and its tributaries.

Energetic cost of girdling in the notodontid caterpillar, *Oedemasia leptinoides*

Brianna Trejo
Faculty Mentor: David Dussourd

Some caterpillars cut a ring around the rachis, petiole or stem of a plant before feeding on distal leaf blades. This girdling behavior has been observed in multiple species of the lepidopteran family, Notodontidae. In one study, caterpillars of *Oedemasia leptinoides* (Notodontidae) spent up to 11% of their time girdling over a 12 hour observation period, whereas another notodontid, *Lochmaeus manteo*, did not girdle at all (Ganong et al., 2012). Girdling is thought to prevent plant responses, possibly by exposing vascular tissues so salivary components can enter the plant, or by severing the flow of plant secondary metabolites to the area in which the caterpillar is feeding. The energetic costs of cutting girdles in tough plant tissues have not been explored. Using *O. leptinoides* and *L. manteo* as model notodontids, I will combine behavioral observations and respirometry data to produce overall energy allocation budgets for each species. I will then test for significant differences in energy allocation between the girdling and non-girdling species. Understanding more about the costs and benefits of girdling and about the co-evolutionary dynamic between girdling caterpillars and their host plants may have widespread significance for tree-feeding caterpillars, including some important pests.

Regulation Of Gene Expression In Rice Roots During Interactions With Nitrogen-Fixing Bacteria

Grant Wiggins, Qinqing Yang, Ha Ram Kim, Christian Melendez, Charlie Wilson, Allee Haynes
Faculty Mentor: Arijit Mukherjee

Biological Nitrogen Fixation (BNF) is increasingly viewed as a viable alternative to fertilizers for supplying nitrogen to plants. Several reports have shown that the BNF in cereals (e.g., rice, corn, wheat, etc.) comes from nitrogen-fixing bacteria. For instance, major cereal crops can form beneficial associations with nitrogen-fixing bacteria like *Azospirillum* and *Herbaspirillum*. Interestingly, these bacteria induce no specialized root structures (e.g., root nodules in legumes) and use different mechanisms to colonize plant roots. Our current understanding of the molecular aspects and signaling that occur between important crops like rice and these nitrogen-fixing bacteria is limited. In this study, we used an experimental system where the bacteria could colonize the plant roots, and then used this colonization model to identify regulation of gene expression at different stages of symbiosis. We used RNA sequencing to identify 1622 differentially expressed genes (DEGs) in rice roots 1day post inoculation (dpi) and 1995 DEGs at 14dpi with *Azospirillum brasilense*. Similarly, we identified 1688 DEGs in rice roots 1dpi and 1515 DEGs at 14dpi with *Herbaspirillum seropedicae*. We identified several host pathways that could be potentially involved in these symbiotic interactions. Our data also suggest the presence of a molecular dialogue between the symbiotic partners that might be crucial for recognition and initiation of these symbioses. Also, we validated the RNA sequencing gene expression results of a few genes via reverse transcriptase polymerase chain reaction (RT-PCR). Findings from this study will improve our understanding of the regulation of gene expression occurring in rice roots during beneficial interactions with nitrogen-fixing bacteria.

Department of Chemistry

Improving Student Success On Lewis Structures, VSEPR Theory, Polarity, And VB Theory

Morgan Burke, Eric Wilcox
Faculty Mentor: Faith Yarberry

Lewis Structures, VSEPR theory, VB theory, and molecular polarity prove to be difficult concepts for students in freshman-level chemistry courses. Split-screen lecture videos on these topics have been developed with the overall goal to improve student success in the classroom and on the nationally standardized American Chemical Society (ACS) exam. Student success has been evaluated using their test scores on the end-of-course exam and the ACS exam after completion of an online lab dedicated to viewing the lectures through EdPuzzle.

A Blackboard quiz, administered following the completion of the EdPuzzle video, was used to determine students scores for the online laboratory. End-of-course exam questions and ACS exam questions, related to the videos, was analyzed and compared against the previous three years of student success on these topics. Our data demonstrates the effectiveness of the video tutorials.

Nickel-Nickel Dimers Structurally Reminiscent Of Common Nickel Scorpionates

Triston J. Clements
Faculty Mentors: Patrick J. Desrochers, Nikolay Gerasimchuk

As part of our work on nickel scorpionate complexes, a new class of nickel-nickel dimers was discovered in our laboratory. These [Cl-Ni(mu-pz)$_3$Ni-Cl] anionic dimers were synthesized by direct reaction of sodium pyrazolide and tetrachloronickelate(II) ion in DMF. This general synthetic approach was used for a variety of pyrazoles: pyrazole, 3,5-dimethylpyrazole, 3,4,5-trimethylpyrazole, and 4-chloro-3,5-dimethylpyrazole. Dimer formulations were confirmed by MALDI-TOF mass spectrometry. These have also been characterized by electronic and infrared spectroscopies. Electronic spectra of these dimers show characteristic signatures of previously reported (Tp^R)NiX complexes. The structure of this new class of dimer was discovered by single crystal XRD for the dimethylpyrazole nickel-nickel dimer. The nickel-nickel dimers structural and reactivity characteristics are compared with its close relative, Tp*NiCl (see figure). Work is ongoing in our laboratory to describe the reactivity and magnetic characteristics of this new nickel-nickel dimer class.

Synthesis Of Aryl Selenide Amino Acid Radical Precursors

Eriq D. Deaver, Jarett D. Duvall
Faculty Mentor: K. Nolan Carter

Proteins and other biomolecules are subject to damage by reactive oxygen species such as hydroxyl radical. This process is believed to play a role in aging and diseases such as cancer. The reaction of hydroxyl radical with proteins is complex since hydroxyl radical is non-specific and can attack many sites within the polypeptide chain. Due to this issue, studying the role played by specific radical intermediates in protein damage is difficult. To facilitate the study of this process, a strategy using aryl selenide radical precursor compounds has been employed. In contrast to hydroxyl radical that produces numerous radicals from a given amino acid, this approach enables selective generation and study of a single intermediate. The monomeric amino acid radicals produced from these precursor compounds are intended to serve as models for the radicals formed within a protein. The lability of the C-Se bond and the difficulties associated with working with benzeneselenol make the synthesis of these compounds non-trivial. The current work describes efforts to synthesize and reduce an oxime intermediate under mild conditions as well as development of conditions that enable in situ generation of nucleophilic selenium species.

Decomposition Pathways Initiated by $Fe^+(^6D)$ and FeX^+ (X=Cl, Br, I) in Halomethanes with Significant Global Warming and Ozone Depleting Potentials

Angela B. Eden, Christopher L. Emmerling
Faculty Mentor: William S. Taylor

The gas phase reactions of $Fe^+(^6D)$ and FeX^+ with CF_3X, (X=I, Cl, and Br), were examined using a selected-ion drift cell reactor. FeX^+ reactions studied included those where the halogen on the metal and the neutral were the same as well as those in which they differed. The objective of this work was to determine the effects of ligated metal ions on the decomposition pathways of CF_3X, all of which exhibit negative environmental impacts as a consequence of their global warming and/or ozone depleting potentials. All reactions were carried out at a total pressure of 3.5 torr at room temperature. Fe+ reactants were made using a sputtering glow discharge with Ar as the working gas, and FeX^+ ions were made by producing Fe+ ions and then reacting them in a collision cell using a rectilinear quadrupole that was filled with a mixture of CH_3X in He at a mole fraction of 10^{-3}. Reaction results showed that Fe+ reacted inefficiently with CF_3Cl to yield the association product exclusively, and with CF_3Br to form $FeBr^+$ as the sole bimolecular product. Conversely, Fe^+ initiates a number of efficient fragmentation pathways with CF_3I. In reactions of FeX^+ with CF_3Cl and CF_3Br, ligating the iron center with X increased the rate of reaction by a significant amount (at least 30%) when compared to bare Fe^+ reacting with the same neutral. This effect is more pronounced when the halogen is more electron-withdrawing. Products in the FeX^+ reactions provide direct evidence of a number of processes, including both C-X and C-F bond activation, and in some cases halogen-switching.

Fd&C Dye Content Of Popular Beverages

Rachel Haislip
Faculty Mentor: Robert Mauldin

In recent years, concern has been raised about the safety of artificial food colorants. The safety of these dyes in children and adolescent populations is of particular interest as some studies have linked these dyes with allergic reactions and attention problems. Currently, American companies are not required to disclose the amount of artificial food colorants used in their products. This project seeks to determine the quantity of three of the most common food dyes – Red 40, Blue 1, and Yellow 5 – in popular beverages using UV-visible spectroscopy and Beer's Law.

Determination of the Origin of Caddo Artifacts Using SEM-EDS

Lindsey Hazeslip, Anna Suarez-Davis
Faculty Mentors: Robert Mauldin, Tom McCutchen, Duncan P. McKinnon

The purpose of this project is to analyze a set of Caddo artifacts, currently on loan from the Arkansas Archeological Society, in order to determine whether they are naturally occurring or human-made. They were excavated from Mound 2 at the Bowman site in the 1960's. It was hypothesized that the artifacts are a type of "iron concretion" that built up over time due to the flow of water through the sediment near the Red River. This project used a scanning electron microscope (SEM) with an energy dispersive x-ray spectrometer to analyze the artifacts. The SEM helped determine which elements are present, and provided a rough estimation of the percentage of each element in the sample. The SEM is a non-destructive instrument, allowing for the same piece of sample to be used in further tests. The SEM identified sand (SiO_2) particles embedded in an iron oxide matrix in the exposed interior of the sample, which supports the hypothesis that these artifacts are naturally occurring "iron concretions" and not human-made.

Synthesis And Characterization Of Novel Fluoro-Bridged Copper Complexes

Bryce Johnson
Faculty Mentor: Lei Yang

Introduction of C-F bonds into organic molecules is a very active research area due to the significance of fluorinated compounds in agriculture, pharmaceutical and medical industry. Although some exciting progresses have been achieved through different synthetic approaches, this task remains as a great challenge. In our effort to further understand the possible catalytic mechanism and develop copper catalysts with better efficiency, we used Cu(II) and Cu(I) complexes supported by a simple diamine ligand to react with fluorine reagents. Interesting color changes were observed at low temperature. In addition, three new fluoro-bridged copper clusters were isolated and characterized by X-ray crystallography, UV-vis, EPR and FT-IR. Currently the catalytic function of the copper complexes towards iodobenzene with AgF as the fluoride source is under investigation.

Toward The Synthesis Of Chalcone-Based Drugs For The Treatment Of The Neglected Tropical Disease Leishmaniasis

Victoria Marcelle, Leah Evans
Faculty Mentor: Gregory R. Naumiec

Leishmaniasis is a rampant, neglected tropical disease (NTD) whose primary treatment is seeing alarming rates of drug resistance and whose secondary treatment is highly toxic toward those infected, most notably in sub-saharan Africa. There are over 12 million cases each year and 46 thousand annual fatalities. Leishmaniasis is caused by sand flies that are infected with protozoan parasites. The sand flies initially consume blood from canid or rodent hosts, then infect humans when injesting their blood. Humans can contract cutaneous, mucosal, or visceral leishmaniasis, depending on the species of leishmania that infects them. Cutaneous leishmaniasis causes skin lesions, while the mucosal infection occurs when the cutaneous leishmaniasis metastasizes to the nasal and pharyngeal regions of the body. However, visceral leishmaniasis affects mainly the internal organs of the patient, particularly the spleen, liver, and bone marrow. It is the most fatal of the three when left untreated, as one might expect. The purpose of the research is to discover new drug candidates, based on the natural product chalcone, to treat leishmaniasis by synthesizing a variety of chalcone drug candidates from substituted benzaldehydes and acetophenones via aldol condensation reactions. The drug candidates can be synthesized in as little as one step in moderate to high chemical yield. Additionally, once purified, these drug candidates anti-microbial activity were initially tested. Two of the five drug candidates tested demonstrated antimicrobial activity, although neither of them were as effective of an antimicrobial as the ampicillin control. We hope to apply these findings to construct an organic chemistry teaching laboratory procedure in the future. In this, the students would be able to make various antimicrobials and then test their effectiveness against microbes found from swabbing different areas in the building.

Efficient Preparation of R-Scorpionates from R-Boronic Acids and Microwave Heating

Shelby Margis
Faculty Mentor: Patrick Desrochers

Scorpionates chelates are a class of ligands developed by Swiatoslaw Trofimenko in the 1960's named for their general structure and the way in which they bond to a metal using three "pinchers". Despite the extensive history of these ligands, synthetic routes to R-scorpionates (R-Tp) are still limited to the use of highly reactive boron-halide reagents. Research and development of a more general and chemically safer method will encourage further research on the applications of these versatile tridentate chelates. The present method employs commercially available R-boronic acids, sodium pyrazolide/pyrazole mixtures, and efficient heating using a microwave synthesizer. Typical reaction times range from 10-15 minutes with consistent 100% yields. The widespread availability of R-boronic acids offers an opportunity for expansion of the library of R-scorpionate chelates. For example, R = chromophores, linkers to a solid support, or other functional groups should now be accessible with this method.

Organic synthesis of fluorophore to diagnose neglected tropical diseases

Noella Michael Mwangoka
Faculty Mentor: Gregory R. Naumiec

This research aims to design a chlorin-based fluorophore for potentially diagnosing neglected tropical diseases (NTDs) taking advantage of the near-infrared wavelengths (NIR). NTDs are communicable diseases that affect most developing nations, some of these illnesses include malaria, Chagas, and leishmaniasis. NIR radiation penetrates tissues enabling a chlorin-based fluorophore compound to absorb light the radiation, then fluorescence, thereby making it a useful tool in biomedical imaging to aid in observing molecular targets. The fluorophore will be tethered to a drug and that drug will bind its target, dragging the fluorophore with it. The fluorophore can then be detected 5-8 mm deep in the tissue and uses ultrasonography probes to help visualize the targeted tissue. NIR has the potential to be a great tool for biomedical imaging due to its high accuracy, quickness, and non- destructive processes when targeting the tissues. It extends from 780-2500 nm. This research illustrates the experimental procedures on how the products are synthesized step-by-step until the desired fluorophore is made. We utilized organic compounds such as pyrrole and methyl-4-formylbenzoate as our starting material. We ensured clear separation of our compounds in each step by determining the purity of the compound using the thin layer chromatography. These procedures included thirteen steps and were performed three times to ensure enough yield for further experimentation in the future. The products were characterized by both ^{13}C and ^{1}H NMR spectroscopy and the results showed that the products were successfully synthesized. Further experiments will focus on the completion of synthesis of the fluorophore.

Evaluation Of Potential Pre-Requisites In Determination Of Student Success In Freshman-Level Chemistry Courses

Jordan Preston
Faculty Mentor: Faith Yarberry

In 2012, a direct correlation was identified between the mathematics ACT exam score and student success rates in freshman-level chemistry courses. The results indicated that a 21 Mathematics ACT score greatly improved success rates in General Chemistry for Health Sciences and a 24 Mathematics ACT score was needed for similar success in College Chemistry I. In 2013, the Department of Chemistry adopted a 21 Math ACT score as a pre-requisite for College Chemistry I and General Chemistry for Health Sciences, or a prerequisite/co-requisite of College Algebra. The limiting factor was the alternative method of entry into the course being College Algebra for both. This method, while helpful, did not yield the desired result, which was a panacea for student success. In the Summer of 2015 the Department of Chemistry implemented a Chemistry Placement Exam for incoming students with a Math ACT score of less than a 25. If a student scored greater than 60% on the assessment exam, they were approved to take College Chemistry I or General Chemistry for Health Sciences depending on their major. If they scored less than a 60%, it was recommended that the student take a Fundamental Chemistry course before proceeding into the course needed for their major. The results of the assessments indicated it to be a useful tool, but still not a panacea for student success.

Our research will evaluate and report the impact of Math ACT scores, the Chemistry Placement Exam, College Algebra as a co-requisite, College Algebra as a pre-requisite, and Fundamental Chemistry to determine which tool, or combination of tools, offers the best success rates in College Chemistry I and General Chemistry for Health Sciences.

Synthesis and Characterization of Copper(II) Complexes Supported by Pyridylamide Ligands

Joseph Schneider
Faculty Mentor: Lei Yang

Mixed-valance copper clusters have been proposed as the intermediates during the catalytic reactions of natural copper-containing enzymes such as multicopper oxidase and nitrous oxide reductase. In our effort to make synthetic models of these mixed-valence copper clusters, we used a group of pyridylamide ligands as the platforms to support the copper centers with different oxidation states. Some interesting Cu(II) complexes, such as a one-dimensional Cu(II) polymer and a hexanuclear Cu(II) metallomacrocycle complex, have been synthesized and characterized by X-ray crystallography, IR, UV-vis and EPR. Currently the mixed-valence copper chemistry of these ligands is under investigation.

Synthesis Of Multi-Modal Drugs Toward The Treatment Of Chagas Disease

Rachel Senn
Faculty Mentor: Gregory Naumiec

Neglected tropical diseases affect over one billion people per year, causing effects that range from fever to heart and bowel failure. Chagas disease manifests itself in two forms, the acute phase which causes fever and swelling of the spleen and liver, and the chronic phase which is thought to be the leading cause of heart disease in Latin America, in countries such as Argentina, Brazil, and Bolivia.

Our research focuses on creating multi-modal drugs for the treatment of Chagas disease using short synthetic pathways and inexpensive starting materials.

In working to produce a multi-modal drug for Chagas disease we have started with a relatively inexpensive compound, commonly known as squaric acid. While squaric acid has shown some anti-Chagistic properties of its own, one of its main features is its ability to be further functionalized after being converted to a squaramide, a known class of anti-parasitics that target Chagas disease. Our current work is focused on converting squaric acid to a squaramide via an intermediary dimethyl squaric ester by substituting two di-amino "arms" that are capable of further modification.

Using dichloromethane as a solvent, squaric acid is converted to dimethylsquarate by refluxing it with methanol for twenty-four hours. Dimethylsquarate has then been further modified by adding amine arms. These reactions are quick and simple: the selected amine is stirred in a solvent of dichloromethane with dimethylsquarate at room temperature. These reactions have relatively high yields, typically 70%.

Exploring Effecient Methods For Protein Production In An Undergratuate Lab Setting

Hannah Simpson, Anna Wilson, Josiah Johnson
Faculty Mentor: Tori Dunlap

Calmodulin (CaM) is a calcium-sensing protein that plays a role in regulating enzyme activity. Usually, CaM binds to a disordered region and causes the region to have an alpha-helical secondary structure. Calcineurin (CaN) is a calcium and CaM dependent protein that activates T-cells. PEP-19 is a disordered 62 amino acid protein that binds to CaM and alters CaM's calcium binding kinetics. We used these three proteins to explore and develop a time and labor efficient method for producing proteins in E. coli in an undergraduate laboratory setting. The original method for preparing these proteins was standard IPTG induction, which is problematic for undergraduate labs due to the time-frame required for monitoring cell growth. Autoinduction is a unique method that uses specific proportions of glycerol, glucose, and lactose,a mixture called 5052, to cause the production of protein without needing to monitor cell growth. Traditionally, autoinduction utilizes a specific autoinduction media which contains a complex variety of ingredients making it costly and time consuming to make. The IPTG method often requires the use of a simple, cost effective media called Terrific Broth (TB) that utilizes glycerol as the carbohydrate source. We hypothesized that TB could be used for autoinduction by replacing the standard glycerol with the 5052 mixture from the autoinduction. Here we compare the expression of calmodulin, PEP-19, and calcineurin utilizing the IPTG method, standard autoinduction method, and autoinduction method using TB and 5052 to determine if utilization of TB and 5052 can provide a convenient, cost effective alternative to the IPTG and standard autoinduction methods.

Synthesis Of Espintanol Analogues For The Treatment Of Leishmaniasis

Sean Stokes
Faculty Mentor: Gregory Naumiec

With the reach of neglected tropical diseases (NTDs) spreading into new and more heavily populated areas, the need for safer, more affordable treatments options are becoming more necessary. The current treatment options are chemotherapy with antimony based medications which can be as lethal as the disease itself. Using the naturally occurring drug espintanol as a lead, our goal is to develop novel medications that are more potent and effective while reducing the current levels of toxicity in comparison to current drug regimens. Because espintanol is extracted from an endangered species of tree, synthesis of the drug can be done using squaric acid as a cost effective starting material. Since the first step of the synthesis of espinantol is an alcohol condensation reaction of squaric acid to yield a squaric ester, a wide range of alcohols can be used to create new alkoxy groups on the squaric acid starting material.

Squaramide-Based Anti-Parasitic Drugs Toward The Discovery Of Novel Treatments For American Trypanosomiasis

Emily N. H. Tran
Faculty Mentor: Gregory R. Naumiec

American trypanosomiasis, or Chagas disease, is a neglected tropical disease caused by the parasite *Trypanosoma cruzi*, affecting one sixth of the world's population most prevalently in Central and South America. The two current treatments for Chagas disease utilize the drugs Nifurtimox and Benznidazole, potent anti-parasitic medications that eliminate *T. cruzi*. Though effective drugs, their side effects are extremely harsh, including difficulty eating or passing stool and cardiac complications, which could result in sudden death. Therefore, this research project focuses on the production of a library of drug candidates that are inexpensive yet innocuous to treat Chagas disease. The synthesis of squaramide-based drug derivatives from 3,4- Dihydroxycyclobut-3-ene-1,2-dione (squaric acid) has shown to have anti-parasitic properties against *T. cruzi*. Squaric acid is first converted to squaric esters via condensation with alcohols and are subsequently converted to the targeted squaramides. This class of compounds have demonstrated to have short synthetic pathways, low toxicity in humans, and the potential for high affinity for the *T. cruzi* parasite. Through a series of condensation reactions of three to four steps, an assortment of potential drugs is being created from alkyl and aryl amines. The availability of these compounds will enhance the chances of discovering a new and safer medication for Chagas disease. Currently, significant progress has been made in the synthesis of the first-generation drug library. Future research involves testing the potency of these drug candidates and synthesizing a second generation of drug derivatives.

Improving Success In Freshman-Level Chemistry Laboratories Through Online Procedural Videos

Kaitlyn Walden
Faculty Mentor: Faith Yarberry

Across the nation, more and more professors have started utilizing flipped classroom lectures at the collegiate level. This experiment was designed to test the concept of a flipped lab. In this experiment, several procedural and conceptual pre-lab videos were tested for increased student success in a College Chemistry I laboratories. This experiment compares the test group to two different control groups. The test group received the prelab handouts that contained QR codes linked to the online laboratory videos and were required to watch the videos on EdPuzzle prior to the laboratory. One control received the same handouts as the test group but were not required to watch the videos prior to the laboratory. The second control received all of the information provided on the handouts but did not have access to the lab videos. Pre-lab quizzes were administered to all three groups and used to measure the effectiveness of the test group protocol. The quizzes evaluate student understanding of the pre-lab material presented in the handout.The research presented will show the impact of the required pre-lab videos compared to that of the control groups.

Proposed Teaching Lab And Improved Procedure For The Removal Of Molybdenum And Tin From Waste Generated By The Quantitative Analysis Of Phosphate: Verification By Atomic Absorption Spectroscopy

Molly Wood
Faculty Mentor: Robert Mauldin

The analysis of phosphate, a common undergraduate teaching laboratory, produces waste containing molybdenum blue. See equations 1 and 2 that show the reaction between the molybdate and phosphate with stannous chloride as the reductant, resulting in the formation of the molybdenum blue compound.

According to various safety data sheets, molybdenum (Mo) and tin (Sn) have been determined to be hazardous to the environment. The current standard procedure for the removal of Mo is to increase the pH of the waste with NaOH and precipitate with CaCl2. This research proposes that it would be beneficial to increase the pH with Na2CO3 in order to precipitate molybdenum containing anions as calcium salts and Sn(II) and Sn(IV) as carbonate salts (equations 3-6).

Atomic Absorption Spectroscopy results will be presented to determine the effectiveness of the proposed waste removal procedure. While this treatment will be beneficial to the environment, it would be beneficial to the education of students as well. The improved procedure is proposed as a teaching lab, in which students treat their own waste prior to waste disposal, there by giving students important experience with the treatment of hazardous waste.

(1) $PO_4^{3-} + 12MoO_4^{2-} + 27H^+ \rightarrow H_3PO_4(MoO_3)_{12} + 12H_2O$

(2) $H_3PMo(VI)_{12}O_{40} + Sn^{2+} \rightarrow [H_4PMo(VI)_8Mo(V)_4O_{40}]^{3-} + Sn^{4+}$ (molybdenum blue)

(3) $Ca^{2+}(aq) + MoO_4^{2-}(aq) \rightarrow CaMoO_4(s)$

(4) $3Ca^{2+}(aq) + 2[H_4PMo(VI)_8Mo(V)_4O_{40}]^{3-}(aq) \rightarrow Ca_3(H_4PMo(VI)_8Mo(V)_4O_{40})_2(s)$

(5) $Sn^{2+}(aq) + CO_3^{2-}(aq) \rightarrow SnCO_3(s)$

(6) $Sn^{4+}(aq) + 2CO_3^{2-}(aq) \rightarrow Sn(CO_3)_2(s)$

Department of Computer Science

Evaluating The Generality Of Convolutional Neural Network Feature Maps

Seth Baer
Faculty Mentor: Victor S. Sheng

Convolutional neural networks (CNNs) have become a staple in computer vision. Their widespread popularity doesn't come as a surprise however, considering their high competency in computer vision tasks such as object classification and localization. These networks are typically trained on very large data sets of images, and they can take days to train. One of the key ideas behind the CNN is their ability to produce powerful feature maps. These feature maps are what make the structure so powerful. I am interested in digging into the question of why these feature maps are so powerful, and if that power can be harnessed in order to make more general use of a particular CNN architecture. In this work, I try to answer these questions by taking a proven high performance CNN architecture pretrained on the ImageNet dataset and testing the features with a variety of methods including clustering, and using novel classes.

Multi-Target Regression: Classification Methods Using Targets As Inputs

Eric Bruning
Faculty Mentor: Victor S. Sheng

In the real world there are many instances in which people are dealing with predictions of multiple target variables based on a set of input variables. Tackling multi-target regression has gained interest in the recent years. Multi-target regression is similar to another task, multi-target classification, in that they are both trying to get predictions based on input values. Multi-target classification and regression input variables could be the same; however, target variables are binary and static, while multi-target regression target variables are continuous. Both of these tasks create predictions separately by using different inputs in the set. This creates a challenge in creating relationships between the independent predictions even though there are dependencies. This paper focuses on the problem transformation stage of multi-target regression by using multi-target classification methods that uses an enhanced data set contained of previous target variables as input variables. By building new models with enhanced data sets should create relationships between predictions and improve accuracy.

A Task And Performance Analysis Of Endoscopic Submucosal Dissection (ESD) Surgery

Berk Cetinsaya, Doga Demirel
Faculty Mentor: Tansel Halic

ESD is an endoscopic technique for en bloc resection of gastrointestinal lesions. ESD is a widely-used in Japan and throughout Asia, but not as prevalent in Europe or the US. The procedure is technically challenging and has higher adverse events (bleeding, perforation) compared to endoscopic mucosal resection. Inadequate training platforms and lack of established training curricula have restricted its wide acceptance in the US. Thus, we aim to develop a Virtual Endoluminal Surgery Simulator (VESS) for objective ESD training and assessment. In this work, we performed task and performance analysis of ESD surgeries.

We performed a detailed colorectal ESD task analysis and identified the critical ESD steps for lesion identification, marking, injection, circumferential cutting, dissection, intraprocedural complication management and post-procedure examination. We constructed a hierarchical task tree that elaborates the order of tasks in these steps. Furthermore, we developed quantitative ESD performance metrics. We measured task times and scores of 16 colorectal ESD surgeries performed by four different endoscopic surgeons.

The average time of the marking, injection, and circumferential cutting phases are 203.4 (σ:205.46), 83.5 (σ: 49.92), 908.4 sec. (σ: 584.53) respectively. Cutting the submucosal layer takes most of the time of overall ESD procedure time with an average of 1394.7 sec. (σ: 908.43). We also performed correlation analysis (Pearson's test) among the performance scores of the tasks. There is a moderate positive correlation ($R=0.528$, $p=0.0355$) between marking scores and total scores, a strong positive correlation ($R=0.7879$, $p=0.0003$) between circumferential cutting and submucosal dissection and total scores. Similarly, we noted a strong positive correlation ($R=0.7095$, $p=0.0021$) between circumferential cutting and submucosal dissection and marking scores.

We elaborated ESD tasks and developed quantitative performance metrics used in analysis of actual surgery performance. These ESD metrics will be used in future validation studies of our VESS simulator.

Applying Regression Analysis And Granule Computing In Wine Informatics To Predict Wine Scores

Alexander Dementyev
Faculty Mentor: Bernard Chen, Victor S. Sheng

Wine informatics is a interesting study of wines reviews through applying different data mining methods such as Association Rules, K-means clustering, Naive Bayes classification, Decision Tree, etc.. Nevertheless, the idea of Granule computing, which means to com-bine more than one method, is never used before in this field of study. The paper proposes the use of Granule computing with the combination of K-means clustering and Naive Bayes classification to predict the score (90+ or 90-) of 1010 wines. The performance of the prediction is generated through utilizing 10-fold cross validation.
We also are going to look at how to use regression techniques for classification. Regression techniques can be really good under cer-tain circumstances and we're going to see if we can apply them to ordinary classification problems.
Results that were generated from this research will be able to assist further in-depth study applying Granule computing and Classifica-tion by regression that could help predict the scores correctly. The same algorithms and methods can be applied to other fields (the study of wine or beer) or predict a different labels such as Vintage or Origins.

Partition-Based Optimization Model For Generative Anatomy Modeling Language (POM-GAML) For Anatomy Modeling

Doga Demirel, Berk Cetinsaya
Faculty Mentor: Tansel Halic, Sinan Kockara, Shahryar Ahmadi

In our prior study we developed a constraint based (e.g. joints) human anatomy modeling language (GAML). In this paper, we present a novel approach for Generative Anatomy Modeling Language (GAML) to speed-up the exponential execution time due to nonlinear constraint based optimization model. For instance, when there are increasing number of constraints in an anatomy, solution of the nonlinear constrained optimization problem takes exponential time. In this study, we introduce a new approach to effectively solve the constraint based optimization problem in linear time by partitioning the problem into sub-problems for increasing number of constraints. In order to partition the problem in to sub-problems, we use different clustering/community detection algorithms (k-means, Clauset Newman Moore, and DBSCAN) were used to find communities and the clusters. GAML was used to create a case study for 3D shoulder model to benchmark our approach with constraints up to 5,000.
Our results show that the computation time is linearly increasing with the increase of the constraints. Moreover, the number of constraints increase, the error decreases. For the largest constraint set (5000 constraints), time was decreased by 99.96% and error is computed as low as 2.2%. This study presents and compares several methods to reduce computation time spent for solving constraint based optimization problem of the non-linear optimization model developed for GAML. A case study for 3D modeling for shoulder models developed for arthroscopy rotator cuff simulation was presented. Our results significantly reduce the computation time in conjunction with error for COBYLA non-linear optimization solver.

Modeling Fluid Flow in Virtual Arthroscopic Tear Diagnosis and Evaluation Platform (VATDEP)

Aditya Dendukuri, Mustafa Tunc
Faculty Mentors: Tansel Halic, Sinan Kockara, Shahryar Ahmadi

Arthroscopy is a minimally invasive surgical procedure for diagnosis and treatment of a joint. Arthroscopic Rotator Cuff (ARC) is a surgical treatment for group of muscles and tendons that connect the upper arm to the shoulder blade. Our goal is to build a virtual simulation platform named Virtual Arthroscopic Tear Diagnosis and Evaluation Platform (VATDEP) of ARC using various modalities including highly realistic real-time visualization, interactive physics simulation and haptic(touch) devices (robotic devices that can deliver force feedback) in collaboration with University of Arkansas for Medical Sciences. The ultimate goal is to develop high fidelity platform to train physicians with quantitative performance feedback. One critical aspect of the VATDEP is to model the arthroscopy irrigation solutions and heat flow for electrocautery procedures. Irrigation solutions are mainly used for safety and efficacy during the procedure. Electrocautery is used to clean and remove the tissue and prepare the footprint before the placement of anchors at the humeral head. A numerical approach is essential for modeling liquid and heat flow as the medium of fluid flow changes continuously as the simulation progresses. Therefore, we utilized a numerical computational technique called Smoothed Particle Hydrodynamics (SPH) to model both heat transfer and liquid simulation. Our formulation intends to virtual simulate complete liquid motion of the irrigation solution and the mechanism of conduction and convection of heat flow within the shoulder cavity in real time.

Arkansas Telemedicine Platform Design And Development For Dermatology: A Secure Cloud Based Skin Cancer Melanoma Detection System For Arkansas

Recep Erol
Faculty Mentor: Sinan Kockara

In this study, we develop a system to help dermatologists to diagnose melanoma in its early stages. Accurate diagnoses of melanoma require expertise, and the progress of the disease may not be noticed by naked eye examination. Computer Systems can detect and analyze even minute changes on skin lesions over time. With this motivation, we develop a cloud-based skin cancer monitoring and diagnosis system to help doctors accurately diagnose skin cancers. We use machine learning and image processing techniques to recognize skin lesions and algorithmically classify these lesions as malignant or benign melanoma. We create any time anywhere accessible, a secure cloud-based platform where images of patiens are stored and processed along with the patient specific unidentified information. Doctors and primary care professionals who use the system can collaborate with each other on patient specific data and can help save more people's lives in Arkansas.

Content And Construct Validation Of Surgical Simulators

Jake Farmer, Recep Erol
Faculty Mentor: Tansel Halic, Sinan Kockara

In minimally invasive surgery, there are several challenges for training novice surgeons, such as unintuitive hand-eye coordination, and limited field-of-view. Typical methods for training include cadavers, mannequins, and apprenticeship, all of which are costly and limited in use. Virtual Reality (VR) surgical simulators are a novel, risk-free, and cost effective way to train surgeons. They allow for ease of setup, repeatability of tasks in a quick and efficient manner, and some offer automatic feedback that does not require expert intervention, thus saving time and money. The aim of this study is to validate the content and construct validity of three different surgical simulators, one for measuring gentleness during surgery, one for arthroscopic rotator cuff repair, and one for cricothyroidotomy and endotracheal intubation procedures. We are discriminating between experts and novices based on several movement features, such as path length, average acceleration, and total time to complete the simulator tasks. Using classification algorithms such as K-Nearest Neighbors, and Support Vector Machines we have achieved up to a 100% accuracy rate in identifying experts, and up to a 90% accuracy rate identifying novices. Clustering algorithms such as K-Means and Mean Shift have also been applied over the dataset, with varying degrees of success, with up to 100% accuracy for experts, but only a maximum of 60% accuracy for novices.

Imbalanced Learning - Smote

Padma Priya Jaladi
Faculty Mentor: Victor S. Sheng

Everything in today's world deals with data and most of the data is imbalanced data. Imbalanced data problem is often found in real world applications, it causes seriously negative effect on performance of machine learning algorithms. There have been many attempts at dealing with imbalanced data sets There are different algorithms for classification of imbalanced datasets out of which smote algorithms is used the most. The synthetic minority oversampling technique (smote) oversamples the minority group in the dataset for better prediction. There is another algorithm developed based on smote algorithm called borderline smote. In this paper I want to apply these tow algorithms on 10 different datasets and compare the results. By this we can know which is better algorithm among them.

Multi-Target Classification and Regression in Wineinformatics

James Palmer
Faculty Mentors: Bernard Chen, Victor Sheng, Sinan Kockara

Wineinformatics is the field which uses machine learning and data mining techniques to glean useful information from wine. In this work, attributes extracted from wine reviews are used to make predictions on three key targets/ labels: price per 750mL bottle, quality based on a 100 point scale, and style derived from the region of origin. Using support vector machines and support vector regression, binary and multiclass classification and regression schemes are applied to price and grade, while binary classification is applied to origin. Several different implementations and techniques are explored to achieve good performance, including both single label and multi-label approaches. Additionally, a class imbalance problem is explored and partially mitigated for the grade label. This work is able to achieve binary classification accuracies of 85.9%, 75.89%, and 88.52% on grade, price, and region, respectively; multi-class classification accuracies of 76.21% and 48.71% on grade and price, respectively; and mean absolute error for regression of 1.59 points and $12.94 for grade and price, respectively.

Classification On Grade, Price, And Region With Multi-Label Methods In Wine Informatics

James Palmer
Faculty Mentors: Bernard Chen, Victor S. Sheng

Classifying wine according to their grade, price, and region of origin is a multi-label and multi-target problem in wineinformatics. Using wine reviews as the attributes, we compare several different multi-label/multitarget methods to the single label method where each label is treated independently. We explore both single label and multi-label approaches for a two class problem for each of the labels and we explore both single label and multitarget approaches for a four class problem on two of the three labels, with the third label remaining a two class problem. In terms of per-label accuracy, the single label method has the best performance, although some multilabel methods approach the performance of single-label. However, multi-label/multi-target metrics approaches do exceed the performance of the single label approach in certain multi-label/multi-target evaluation metrics.

Interacting With Robots By Utilizing Virtual Reality Technology

Nicholas Pruss
Faculty Mentor: Yu Sun

Due to recent technological advances, both robotics and virtual reality have become much more sophisticated in the past few years. The combination of these technologies leads to some interesting applications that allow us to interact with computers in new ways. In this project, I explored how an Oculus Rift virtual reality headset could be used to control an EZ-Robot JD Humanoid robot. The Oculus Rift is commonly used for playing video games, but it is also possible to create custom applications that take advantage of the unique sensors found in the headset and controllers. The EZ-Robot JD Humanoid robot has a variety of features that are designed to be easy to use, and it can be controlled via Wi-Fi using a computer or mobile device. By developing several applications with the C++ and C# programming languages, I was able to use the Oculus Rift to control the robot's head and hands in real time. For example, the user can tilt his or her head to make the robot look in a certain direction. This project could certainly be expanded in the future to provide additional controls and utilize the virtual reality headset's display, but it provided a good starting point to experiment with both robotics and virtual reality technology.

Using Computer Vision Techniques for Parking Space Detection in Aerial Imagery

Andrew Regester
Faculty Mentor: Vamsi Paruchuri

We propose a automated mapping algorithm that uses computer vision to analyze and map the location of parking spaces from aerial images of parking lots. The analysis method developed made use of line detection coupled with selective filtering based on the prevalence of line length and angle. The goal of this algorithm was to provide a means of automated detection of regions of interest in parking lot images for further use in collection of parking data.

Aerial images used for development and testing were collected via a quadcopter. The quadcopter was equipped with a camera mounted via a gimbal that maintained a camera angle parallel to the parking lot surface. Video was collected from an altitude of 400 feet and individual frames were selected for content. The images were then split into a development set and a testing set.

For analysis, images were converted to grayscale followed by the application of a binary filter. Line features in the binary images were then detected using a Hough transform. Resulting features were then analyzed iteratively to find recurring line patterns of similar length and angle. After filtering for noise, line end-points and intersections were grouped to estimate individual parking space locations.

Testing showed a parking space detection rate of 76 percent was achieved and a parking line detection rate of 82 percent. This method proved to provide acceptable results for automated extraction of regions of interest from aerial images for mapping or further analysis. Further development that addressed variations in light and improvements in line filtering would further improve results.

New Applications For Using The Deep Learning Algorithm To Identify And Study Skin Cancer

Susan Shaw
Faculty Mentor: Yu Sun

Deep learning plays a vital role in the early detection of cancer. More people are diagnosed with skin cancer in the United States each year than all other cancers combined. The annual cost for treating skin cancers in the U.S. are estimated at $8.1 billion. The good news is that early detection can save not only billions of dollars but countless lives. In cases where early detection is reported, the costs of treatments are reported to be fairly low and a five year survival rate of 95% is reported. Early detection can save not only billions of dollars but countless lives. Deep learning has shown capabilities in achieving higher diagnostic accuracy results in comparison to many field experts. This paper will explore the impact of deep learning on the oncology industry, as well as new applications and areas of exploration that can assist in early skin cancer detection.

Dynamic Voxelization For Virtual Rotator Cuff Surgery

Mustafa Tunc

Faculty Mentors: Tansel Halic, Sinan Kockara

Arthroscopy is a minimally invasive surgical procedure for diagnosis and treatment of joints. Arthroscopic Rotator Cuff (ARC) is a surgical treatment for the group of muscles and tendons that connect the upper arm to the shoulder blade. Surgery training for ARC is challenging due to constrained instrument controls, non-natural hand-eye coordination and limited field of view. Besides, conventional methods used in training such practicing with cadavers, mannequins, or apprenticeship approach make the training costly, risky and non-realistic. In contrast, Virtual Reality (VR) based surgical simulators offer low-cost, risk-free and realistic training and assessment platform. We have been developing a real-time VR based ARC simulation. Drilling a suture anchor into the humeral head is one of the critical tasks of ARC. Existing methods for simulation of the drilling are not sufficient concerning the realism and performance required for the real-time simulator. To achieve a high performance without sacrificing realism, we developed a dynamic voxel-based method. In this method, volumetric 3D geometry such as humeral head are represented by voxels that enables easy surface creation, robust haptic interaction and low memory usage. However, an accurate geometric representation requires small voxel sizes and this causes a huge computational burden. Instead, we proposed a novel method based on Dynamic Proximity Hierarchy (DPH) which is a graph spanner based hierarchical map of approximate shortest paths of a point in the geometry. Using DPH, the sizes of the voxels can be adjusted for appropriate resolution or level of detail. Finer resolution can be dynamically created based on a proximity of drilling object or the field of view without extra surface generation. Since DPH serves a computationally efficient interaction and visual rendering, a 3D scene is rendered at nearly 60 frames per second and twice as much resolution than a rending without DPH.

Department of Geography

Vegetation Cover And Erosion Vulnerability In The Lake Maumelle Watershed, Arkansas

Ashley R. Barto
Faculty Mentor(s): Matthew H. Connolly

Vegetation along mountain bike trails slows erosion and sediment loss. Recreational activities like mountain biking can reduce vegetation and biodiversity surrounding trails. As mountain biking becomes increasingly popular in the United States, studying its impacts on trail vegetation cover and sediment loss is important. The Lake Maumelle Watershed provides drinking water to over 450,000 Arkansans, but the implications of mountain biking on the Ouachita Trail in the Lake Maumelle Watershed are not well understood, nor is there data on the vegetation along the trail. Therefore, I identified percent vegetation cover along edges of steep segments of the trail using GIS and field reconnaissance.

High risk areas were identified with GIS software by selecting steep segments and trail sections near Lake Maumelle tributaries. I visually categorized steep trail segment edges by their percent vegetation cover classes of <25%, 25-49%, 50-75% and >75%, which are easily discernable thresholds. Using cover class and general cover type data, I modeled sections of the trail lacking vegetation that could mitigate sediment loss. For this model, lack of vegetation cover, steep slopes, and proximity to streams were indicators of erosion potential.

My results model erosion vulnerability along the Ouachita Trail as a function of vegetation deficiencies, slope, and tributary proximity along the Ouachita Trail. I found 42.5% of adjacent trail edges were vegetated. My findings inform land managers of high concern areas in the watershed, and they demonstrate the need for vegetation and restoration if mountain biking becomes popular on vulnerable stretches of the trail.

Potential Electoral Impacts Of Gill V. Whitford

Jesse Hardin Hufstedler
Faculty Mentor: Michael Yoder

Gerrymandering has a long history in the United States. In opposition to this practice, The Supreme Court has established two constitutional standards by which gerrymandered districts may be invalidated. These standards, the inappropriate consideration of population and race, were established under the equal protection clause of the fourteenth amendment. The first standard, known as the “One man, one vote” doctrine, is exemplified in the case Baker v. Carr (1962) while the second, inappropriate consideration of race when drawing districts, was established in the case Shaw v. Reno (1993). This historical gerrymandering, however, is vastly different than the new, technologically sophisticated, partisan gerrymandering which has been brought before the Court in the last decade. Currently, the Supreme Court is deliberating on the case Gill v. Whitford out of Wisconsin wherein sophisticated computer modeling (i.e. GIS) was used to pack and crack voters in order to engineer the desired partisan outcome. Since neither race nor geographic location were per se the motives in that case, no current constitutional standard invalidates the districts drawn. Cases of this type are becoming more common across the United States, as GIS becomes increasingly more ubiquitous and accurate. This poster will explore historical population and race based gerrymandering (including how districts were drawn before GIS modeling) as well as modern partisan gerrymandering in the hope of extrapolating potential impacts of a decision for the plaintiffs in Gill v. Whitford.

What Level Of Complexity Is Necessary? A Comparion Of Runoff Potential Modeling Techniques In A Small Watershed

Mark E. Mahar
Faculty Mentor: Matthew H. Connolly

In hydrological studies, or studies with a hydrological component, a lot of time can be spent selecting and running models to determine precipitation potential runoff path and intensity. Runoff potential estimates are useful for understanding water quality, sediment transport, and potential flood zones. This study examined whether or not a generalized runoff potential layer created using relatively simple inputs such as elevation data, land use data, and soil data is statistically similar to runoff potentials created using more complex models. Runoff potential estimates for two different models: SWAT (specifically ArcSWAT) and HEC-GeoHMS were compared to the generalized model for a single subbasin in the Lake Maumelle Watershed in Central Arkansas. This subbasin is a good example of a small hydrological project which can be challenging for some complex models to process.. Random points were selected with ArcGIS' Create Random Points tool, and assigned the runoff potential value for each method. These random points were used in a t-test to determine if the model outputs were statistically different. Results suggest that all the models differ in their runoff potential output. The complex models outputs provide more information, such as sediment transportation, vegetation presence, potential high risk flood areas or other hazards, but take much longer to execute and produced more generalized patterns.

Department of Mathematics

Modeling Insulin Negative Feedback Production

Thomas Banh
Faculty Mentor: Weijiu Liu

Diabetes is a pandemic. The problem with diabetes originates from the blood glucose regulation system not functioning properly. The goal of this research is to develop a linear mathematical model of this regulation system. A linear mathematical model will help future diabetes research make more effective and comprehensive approach to stimulating solutions to cure diabetes. We designed a feedback system of linear equations that models insulin production as a controller, "u", to lower excess external glucose intake and to modulate the blood glucose level back to a normal range in the bloodstream. Numerical simulations of our model against experimental data were performed to successfully determine "u", the controller.

Eye-Tracking Students Watching Calculus Videos

Kara Graham, Will Gloster
Faculty Mentor: Jason Martin

Calculus is the first stepping-stone into STEM fields. As STEM instruction diverges from traditional methods to adapt to modern standards, it is important to leverage technology to provide students enhanced learning opportunities. Videos present material outside-of-class to support active-learning during class, and have become an essential part of "flipped" classrooms; yet, little is known about how students watch videos. This project is part of a NSF-funded study exploring how students interact with calculus instructional videos, using eye-tracking to document aspects of the video to which students attend. In particular, we focus on an essential calculus concept: derivative approximated by average rates. The video develops student reasoning through representations of distance and time. Results demonstrate that students attend to representations in various ways that may affect their performance. Our results may inform video designs that promote an enhanced understanding of calculus in Arkansas.

Kernel Density Estimation

Nathaniel Gregg
Faculty Mentor: Janet Nakarmi

Estimates of the probability density function of a random variable are used to detect skewness, multimodality, and anomalies. Histograms are the simplest tools used for density estimation, but they are slow to approximate the underlying distribution for continuous random variables because they are rough. We use kernel density estimation (KDE) to get a smoothed distribution. We explore the process of calculating a KDE in R-studio. We applied the fast Fourier transform to compute KDE as a finite impulse response filter, as used in signal processing. This allows for the calculation of the optimal smoothing parameter by cross-validation, a process that would be too time-consuming without the more efficient method.

Investigating Students' Graphical Reasoning In Mathematics Using Eye-Tracking

Kayla Waters, Wesley Martsching
Faculty Mentor: Jason Martin

Calculus is the first stepping-stone into the STEM pipeline, but many students are not accustomed to the dynamic nature of Calculus. Much of this confusion results from lack of proper foundation in covariational reasoning; how a student conceives of two quantities' magnitudes varying over conceptual time (Thompson, 2011; Stevens, 2017). To move away from static ways of reasoning about graphs, students must develop a ways of thinking about individual quantities (i.e. distance from 0 to 5) instead of mere locations (i.e. the number 5 as a point on a number line). Different levels of variational reasoning include: the student envisioning a variable can have different fixed values but would need to envision different scenarios to do so (no variation); the student envisions that the value of a variable increases or decreases, but gives little or no thought that it might have values while changing (gross variation); or the student thinks of variation of a quantity or variable's value as increasing or decreasing by intervals while anticipating that within each interval the variable's value varies smoothly and continuously (smooth continuous variation).

Relatively little is known about how students precisely attend to graphical images and how that attention influences this type of reasoning. In this study we investigate how students attend to graphical images using eye-tracking to document aspects of the images to which students attend. We also document their covariational reasoning or lack thereof and then attempt to correlate their reasoning with the aspects of their attention. Data consists of audio/video and eye-tracking records collected from calculus students through a series of one-on-one 50 minute task-based interviews while interacting with static and dynamic graphical images. Early results demonstrate students' reasoning, mostly variational, while attending to depictions for one quantity.

Nonclassical Symmetries of a Harry Dym Equation

Andrea Weaver
Faculty Mentor: Danny Arrigo

It is generally known that classical point and Lie symmetries of differential equations can be different. It has recently been shown for a general class of nonlinear Convection-Diffusion equations and nonlinear Wave equation, that their nonclassical symmetries are contained within the nonclassical symmetries of equivalent systems. We ask if this is true for the power law Harry Dym equation. We calculate the classical and nonclassical symmetries of both the original equation and the equivalent system. We show that both the original equation and equivalent system possess their own special separate symmetries.

Simulating Spatial Spread Of Epidemics Using Mathematics

Azaryah Wilson
Faculty Mentor: Long Le

The epidemic spread of diseases and disease-likes is of great interest in mathematics, and Mathematical Epidemiology is a field that has been growing and advancing for nearly a century. The purpose of this research was to move beyond the standard epidemiological models that attempt to calculate the impact and speed of a disease in an abstract population, and move into simulating populations and their behaviors which are based on their location and situation. To this end, we model populations spreading throughout their environment, and attempting to avoid prolonged contact with those whose infection is evident. We observe the phenomena of infection waves and germ spread.

Department of Physics & Astronomy

Using An Xrf To Investigate The Effects Of Cosmic Radiation On Ion Channel Proteins

Seth Barr, Maria Neal
Faculty Mentor: Azida Walker

During space exploration, one of the risk factors that needs to be addressed is radiation exposure. Astronauts on the International Space Station are generally exposed to 80-160 mSv throughout their 6-month missions. On average, a human on Earth would be exposed to 1 mSv during this time. As NASA strives for longer missions to the ISS, or even missions to Mars, it becomes even more important to understand the effects of this radiation exposure. With our research, we ventured to learn more about how cosmic radiation exposure effects the Shaker channel stably transfected on an HEK 293 cell. We did this by exposing HEK-293 cells to low-grade X-ray irradiation from an XRF-Experimenter's Kit, designed for X-ray spectroscopy. Then observing the effects on the Shaker potassium channel using immunofluorescence. We present here the calibration of our device to produce dosages similar to those that astronauts would encounter in space, as well as the data for the cell viability across varying exposure times, and our initial immunofluorescence studies.

Designing And Programming An Automated Environmental Simulation System

Seth Barr
Faculty Mentor: William V. Slaton

When studying plants or animals, it is important to be able to maintain an environment similar to the native environment of the species being studied so that, as variables of interest are manipulated, the correlating results can more easily be attributed to said variables. Starting with a mathematical model relating latitude and the position of Earth in its revolution around the Sun, a Raspberry Pi microcontroller was programmed using python to calculate the length of day based upon a user specified latitude and start date. The program would then replicate these conditions by interfacing with a servo-driven dimmer switch controlling an array of incandescent lights. In order to increase the accuracy of the environmental replication, this mathematical approach was discarded in favor of a real-time replication approach, which would account variations in brightness attributed to cloud cover, time of day, and season. To achieve this BeautifulSoup, a web-scraping package for Python, was used to access data from WeatherUnderground.com for a user-selected weather station. The program would then search the scraped data for relevant values pertaining to brightness, and then replicate it in real-time. This approach would also allow the project to easily be expanded to also replicate temperatures and simulate precipitation.

Gamma-Gamma Correlation

Jake Bass, Sonja Wagner
Faculty Mentor: Rahul Mehta

The sodium isotope we analyzed in this experiment, Na-22, undergoes β-- decay, which results in a positron being ejected from the decaying atom. This resulting positron is captured by another electron in the sample, resulting in their mutual annihilation. The result of this annihilation is two identical gamma rays (each with 511 keV of energy), which are ejected from the sample. Because momentum has to be conserved, these gamma rays are theoretically ejected in polar opposite directions. Our experiment was designed to test this theory by employing two identical radiation detectors equidistant from the Na-22 sample, and recording each instance of a simultaneous 511 keV gamma reading of the two detectors at varying angles (164-196 degrees). The results of our experiment was precisely as predicted: when the detectors were at 180 degrees with respect to one another, we gathered the greatest number of gamma-gamma detections, and the further we deviated from 180 degrees, the fewer detections were read, with almost no detections read at 164 and 196 degrees.

*We'd like to acknowledge Dr. Duncan Weathers at the University of North Texas for his assistance with this experiment.

X-Ray Fluorescence

Timothy Brown, Jalen Greer
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X-ray fluorescence is used to identify elemental and chemical make-ups of materials such as metals, building materials, and soil samples. A sample is bombarded with X-rays, exciting the particles that make up the material. These X-rays cause photoelectric interactions in the sample. The characteristic X-rays that are produced by these photoelectric interactions are then counted by a low-energy X-ray detector, and through examination of the energies, the elements within the material can be identified as each element emits photoelectric interactions at a different energy value. Samples of known compositions were tested and the emission energy values were recorded. After plotting the known values, a best-fit line was used to find the composition of unknown samples

Effects of Simulated Microgravity and Cosmic Radiation on the Mechanical and Chemical Properties of Rat Femur and Tibia Bones†

Sidney G. Freyaldenhoven, Jordan S. Barajas, Hayley N. Heacox
Faculty Mentor: Rahul Mehta, Brent Hill

It is accepted that the skeletal system of humans is susceptible to space conditions such as microgravity and cosmic radiation, with effects such as decreased bone mineral density and strength. This research analyzes rat femur and tibia bones when exposed to hind-limb suspension (HLS) for 14 days and 0.5 GY x-ray irradiation (IR) administered over 10 days, thus simulating microgravity and cosmic radiation; then, quantifies mechanical and chemical properties, elasticity of bones and calcium and phosphorus content,respectively. It is hypothesized that if microgravity and cosmic radiation lead to decreased bone mineral density, then these conditions will produce weakened bones, lower elastic moduli and abnormalconcentrations of calcium and phosphorus, as compared to bones not subject to these conditions.

To assess the physical changes of the bones, a three-point bending technique was employed to estimate the Young's (elastic) modulus for the leg bones. There was no statistical difference in the elastic modulus for data sets 1, 2, or 3. However, trends suggest that the IR, HLS, and HLS-IR produced lower elastic moduli.To investigate the chemical nature of the bones, a Scanning Electron Microscope (SEM) was used to take cross-sectional images and an Energy Dispersive x-ray Spectroscopy (EDS) was used to perform elemental analysis. Elemental changes vary not very significantly between CON and IR in data set 1; while, the elemental composition is lowest in joint proximities (hip and knee) in CON and IR. Currently, data sets 2 and 3 are undergoing SEM-EDS analysis. Ultimately, the results produced by this research will aid in quantifying the effects of spaceflight on the strength and composition of the human skeletal system.

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Cooperative Student-Built Multi-Payload Balloon-Satellite Eclipse Measurement

Russell Jeffery
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Six high altitude balloon payloads were built and flown in the path of totality on during the 2017 total solar eclipse across the US. The payload flight controllers consisted of Raspberry Pi computers running code written in Bash and Python 3.4 to collect and store data from sensors. The program on each payload collected data from an external temperature sensor, an internal temperature sensor, a pressure sensor, a light sensor, a GPS unit, and a camera. The design also incorporated a smart internal heater to prevent the payload from freezing. The payload design, circuit, and code will be presented along with lessons learned and plans for future work. This project was made possible by a Robert Noyce Teacher Scholarship, a subaward from the Arkansas Space Grant Consortium, and Student Research Funds from the Department of Physics and Astronomy at the University of Central Arkansas.

Effects Of Autistic Youth In Science

Garrett McKamie
Faculty Mentor: Debra Burris

Autism and other varying disorders who qualify on the autistic spectrum have been a topic of growing biological and neurological research in the past decade. Theories propose that many of the greatest minds we've ever encountered through time were actually on the autistic spectrum in some way or another. Some of the names related directly to science who were believed to be on the spectrum were Sir Isaac Newton, Albert Einstein, Nikola Tesla, and Paul Dirac to name a few. As research into autism grows, so has the understanding of the historically unknown genetically induced syndrome. Autism is now believed to be the overuse of parts of the brain compared to people who are not believed to be autistic. This overuse of the brain is linked to phenomenal academic abilities some autistic people exemplify. But society has vast a dark shadow over people with autism and limited them to confined boundaries that could be limiting our scientific success up to date. The subject of this research is to determine if this societal confining of autistic people has confined our autistic youth leading them to believe that no matter their interest level in science, they will never be ab le to be a scientist because they're "special". The test performed will be for the students to create an image of what they believe to be a scientist through a stick figure. There are two expected results, one being that the students build a stereotypical mad scientist they may have seen on TV and other media outlets. The alternate expected result of the experiment will be that the kid's interpretation of a scientist would resemble their self-image, indicating that the kids realize that they themselves are capable of being a scientist regardless of the social confines placed on them.

Analyzing The Changeover From A Macrosystem To A Nanosytem By Investigating The Moving Boundary Between Two Phases.

Paul Niyonkuru
Faculty Mentor: Stephen Addison

In macroscopic thermodynamics, the variables that we deal with are either extensive or intensive. When we explore nano materials some properties that are extensive on the macro scale are no longer extensive, and as systems get smaller some of the intensive properties become less well defined. We will present the results to date of our investigations of the moving boundary between two phases of the same material in both a nano system and a macroscopic system. This is known as the Stefan problem. We analyze this problem for both a macroscopic system and a nano-systems with the method of lines adapted to a MatLab code. The goal of the research is to gain a better understanding of the changeover from a macroscopic system to a nano system. Calculations were made for radially symmetric systems that are gold as there is an extensive literature devoted to the measurement of the properties of gold particle nano systems.

Rutherford Backscattering Spectrometry

Paul Niyonkuru
Faculty Mentor: Rahul Mehta

In Rutherford backscattering spectrometry the energy ratio of the emitted to the scattered particle beam, called the kinematic factor K, shows that the energy after scattering is determined only by the masses of the particle and the target atom and the scattering angle. This result allows to determine the mass, hence, the chemical nature of the target atom by only knowing the kinetic factor, the mass of the particle and its scattering angle. In this project we determine the chemical composition of an unknown sample by shooting it with an incident 1MeV particle beam of He+ scattered at an angle of 135 degrees.

Drake Equation

Clifton Peck
Faculty Mentor: Debra Burris

In this study the researchers will be finding the probability of another habitable planet in the Milky Way Galaxy by analyzing the Drake equation. This equation considers all the variables relevant to finding another civilization, then multiplies the variables together to form a realistic probability. The researchers will use the equation to form their own figures for each variable. The new equations will consists of the seven variables that make up the Drake equation and will be compared to the original probability outcome. Once the new equation is obtained, the researchers will perform error analysis to determine the accuracy of the outcome.

Thermodynamics Of CPU Cooling Solutions

Austin Rutledge
Faculty Mentor: William Slaton

With the widespread usage of computers today, it is important to study the effects of thermodynamics on a per component level. The objective of this research is to look at the ways common Computer Processing Units (CPU) coolers dissipate heat. High temperature damages silicon components leading to failure of the CPU. This project will give a better understanding behind why many CPUs die with coolers that seem adequate but are not good enough to dissipate the heat produced. The recent increase in the average power output of modern CPUs makes this an interesting case, as many of these are being slowly damaged by the heat they produce. An apparatus was custom made for testing the cooling power capability and the temperature of three modern CPU coolers. Temperature was measured in four different locations. Each location has a specific importance, but the block temperature and cooler core temperature were used for this analysis. Each cooler used the same thermal interface material between each test to limit cooler disparity. Pulse width modulation of a 100 watt heater core was used to accurately test different power levels representing CPU power output. Using a simple power equation the temperature and thermal constants can be found. Both modulated power and temperature difference values can be used to predict what CPU power maximum each cooler can theoretically dissipate at a given temperature difference. This research will detail why certain coolers fail to keep temperatures of modern CPUs in check by using tested temperature differences, analysis of these temperatures, and input power.

Development Of An Acoustic Scanner

Nicholas Scoles
Faculty Mentor: Carl Frederickson

Hardware and software are being developed to create a system that can be used scan a 2-dimensional acoustic wave field. The system consists of two linear actuators aligned perpendicular to each other. Mounted on the scanner is a 1/4” microphone. The system can scan a region 30 cm x 30 cm. Software has been developed in Python to control the position of the microphone, the source signal, and the recorded signal. This system can be used to produce acoustic holograms as well as 2-D images of acoustic wave fields.

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