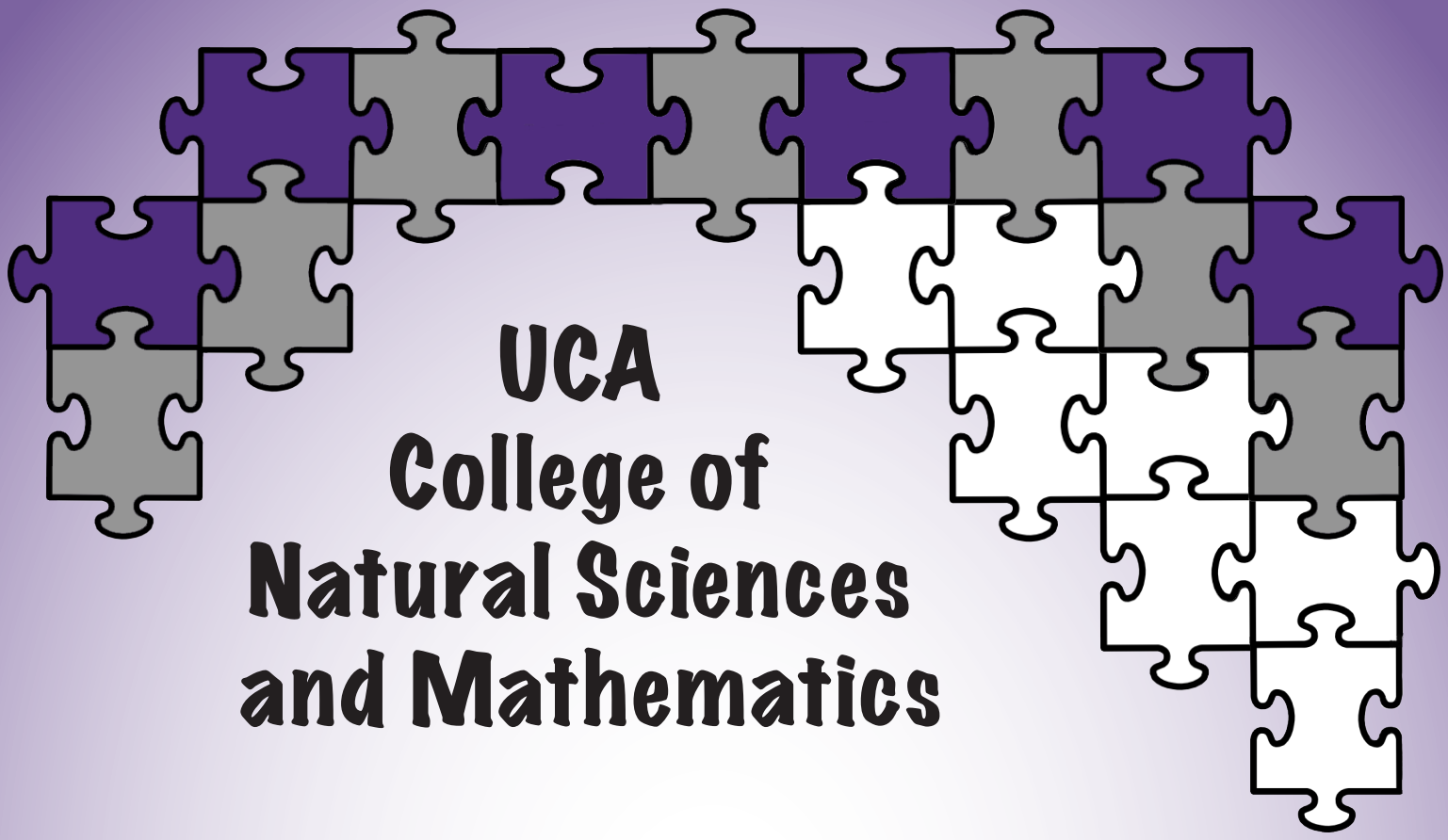
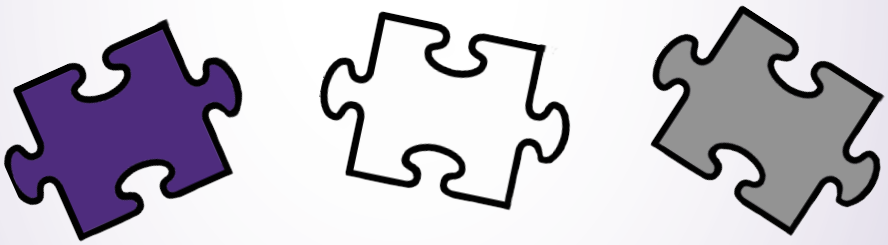


UCA
College of Natural Sciences and Mathematics

22nd Annual Poster Symposium



HPER Gymnasium
April 15, 2016
2-4 P.M.

Welcome from the Dean
College of Natural Sciences and Mathematics

Welcome to the 22nd 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 81 posters involving 125 students mentored by 45 different faculty members. We encourage you to drop by the HPER 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
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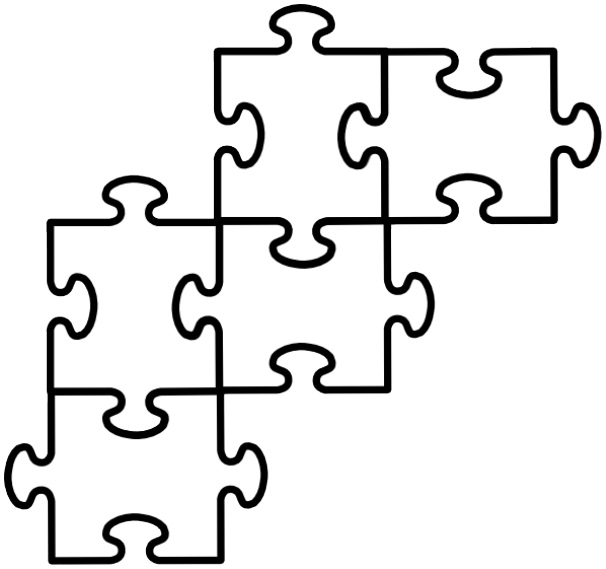
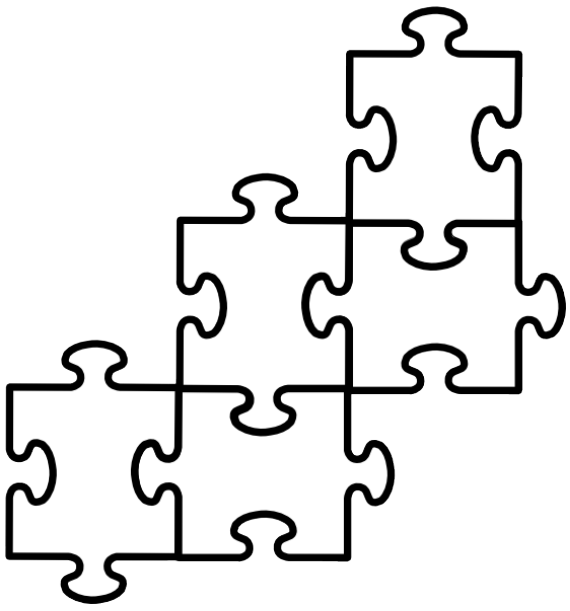
Table of Contents



Department of Biology



Determinants of Dispersal Patterns in the Stream Salamander, Desmognathus brimleyorum

Amber L. Anderson
Faculty Mentor: Matthew E. Gifford

Dispersal is a fundamental ecological and evolutionary process. An individual's propensity to disperse is dependent on a variety of both extrinsic and intrinsic factors. Variation in local population density can have profound effects on dispersal strategies of individuals. The probability of dispersal is often dependent on population size such that a positive relationship between population density and dispersal probability is observed. A spatially explicit mark recapture study is being conducted to better understand the multiple factors (stream heterogeneity, body size and condition, behavior, and resource limitations) influencing dispersal and population dynamics in the stream salamander, Desmognathus brimleyorum. We predicted that the number of emigrants in a location will be positively correlated with salamander density at that location. Preliminary analysis suggests there is an upstream dispersal bias, which could potentially be a consequence of more densely packed downstream sections. Secondarily, there is a positive correlation between salamander population density in a given stream section and number of emigrants leaving. Additional analysis is needed to identify both the extrinsic and intrinsic factors that influence dispersal along the stream corridor.

Stream Basin Natural Characteristics and Human Disturbances Interact to Alter Macroinvertebrate Diversity

Lucy Baker
Faculty Mentor: Sally Entrekin

Unconventional natural gas (UNG) and agriculture have rapidly converted forested stream basins in Arkansas' Fayetteville Shale. UNG has increased in the past 10 years and requires land-clearing for infrastructure, water withdrawal, and chemicals that could alter water quality. The likelihood that stressors will alter water quality may depend on physical characteristics and existing land use in a basin. Our objective was to adapt and empirically test a recently published multi-metric model to calculate stream basin sensitivity and exposure to human activities in 140 headwater stream basins in the Fayetteville Shale. Basin vulnerability was the combination of basin sensitivity and exposure (sensitivity x exposure) used to compute relative risk to biological degradation. Each stream basin was ranked from 1 to 4 based on across-basin quartiles for each physical characteristic and exposure variable. Sensitivity and exposure scores were sums of all ranked variables. We sampled macroinvertebrates in 40 basins over a gradient of vulnerability in streams with and without UNG. We predicted that macroinvertebrate diversity would decrease as vulnerability increased due to greater habitat alterations. We predicted macroinvertebrate diversity in basins with UNG would experience greater change than basins without UNG. Macroinvertebrate diversity decreased linearly as vulnerability increased regardless of UNG presence. Soil erodibility appeared to drive the vulnerability relationship. Neither sensitivity nor exposure alone explained more variation than the combined metric, suggesting an interaction between human disturbances and natural characteristics. Although diversity did significantly decrease with vulnerability, little variation was described by our model (18%). Our vulnerability model predicts potential for degradation; therefore, basins influenced most by sensitivity may not respond as expected because there have been few human disturbances. We aim to adapt our vulnerability model to improve the predictability in order to use the model as a management tool.

Stonedam Creek Water Quality Survey: Site-Specific Chemical Analyses of Urban Conway Stormwater Runoff

David Black
Faculty Mentor: Sally Entrekin

Water quality monitoring is essential for analyzing, predicting, and rectifying the adverse effects of human activities within watersheds. Watersheds are often exposed to runoff containing both point and nonpoint source pollutants that alter chemical and biological conditions of the receiving streams. This exposure is intensified by urbanization and other human modifications to natural areas, resulting in widespread occurrences of phenomena such as eutrophication and acidification. Within this context, earlier studies of the Stonedam Creek tributary of Lake Conway have indicated that Stonedam Creek is likely experiencing water quality problems, but there is a need for additional data, particularly site-specific analyses of the chemical composition of local runoff. Building on this need, this study quantified common analytes found in stormwater runoff from three urbanized areas connected to Stonedam. The three sampling sites consisted of a section of Stonedam that flows through the UCA campus, an apartment complex downstream of UCA, and a downtown Conway urban drainage basin that connects to Stonedam. Runoff generated during five storms was collected during July-December 2015 and analyzed for pH, alkalinity, specific conductivity, total suspended solids, turbidity, nitrates, total ammonia nitrogen, unionized ammonia, and orthophosphates. Analysis of variance (ANOVA) and Tukey's tests were used to detect significant differences between areas. The results generally indicated similarity between sites for most analytes, but significant differences were found in nitrate and total ammonia nitrogen concentrations, total suspended solids, and pH levels. This data provides a useful representation of typical chemical characteristics of urban Conway runoff during the summer-fall months. However, this study was limited in scope, and large-scale studies are needed which encompass a greater number of both sites and analytes observed.

Architectonic Study of the Sensory Areas and Neocortex in the Nine-Banded Armadillo (Dasypus novemcinctus)

Jordan Blackstone, Alex Kilgore, Morgan Steiner
Faculty Mentor: Jeffery Padberg

Nine-banded armadillos are representatives of one of the most basal groups of placental mammals, superorder Xenarthra, which includes sloths and anteaters. Xenarthrans diverged from other placental mammals approximately 100-65 million years ago. Armadillos are characterized by several unique physiological traits, including low metabolic rates and an ossified carapace. Despite the ubiquity of armadillos throughout North and South America, little is known about the organization of their nervous system. Understanding the organization of xenarthran nervous systems may reveal characteristics that are common to all placental mammals, and differences observed in only early clades. We employed histochemical and immunohistochemical preparations to reveal characteristics of sensory areas in nine-banded armadillos. Coronal and flattened tangential sections were processed for parvalbumin (PV), non-phosphorylated epitopes of neurofilament-H (SMI-32), Calbindin, (Cb) cytochrome oxidase (CO), and Nissl bodies. Primary sensory areas were heavily populated with SMI-32-immunoreactive (ir) neurons. The auditory and somatosensory areas were heavily populated and the motor lightly populated with PV-ir neurons. Cb preparations were difficult to differentiate from the background, except in one case showing staining in layer III. Additionally, visual and auditory areas displayed dense supragranular projections of SMI-32-ir neurons, terminating at layers II and III and PV-ir neurons included multipolar, bipolar, and bifurcated cell-types in the somatosensory area. The hippocampus showed a dense population of SMI-32-ir pyramidal neurons with an extremely dark region that was also PV-ir. Finally the pyriform cortex showed a lattice of dark staining, punctuated by regions of light staining. Based on these results, the xenarthran brain bears similarity to afrotherian's, not typically not observed in other placental clades. It is likely that the stem placental shared characteristics of both extant afrotherian and xenarthran species.

Effects of Glucose and Insulin Signaling on the Lifespan and Stress Resistance of Caenorhabditis elegans

Michael Byram, Julia Myers, and Shalynn Mills
Faculty Mentor: Mindy Farris

Caenorhabditis elegans are nematodes that are non-hazardous, non-pathogenic, and non-parasitic. It is an organism that is widely used because it shares many essential biological characteristics with more complex animals, including humans. This similarity is useful when studying mutations in conserved pathways and how they affect lifespan when being stressed. DAF-2 is the only insulin receptor in C. elegans, and the daf-2(e1370) mutation extends the C. elegans lifespan to almost double its normal level, and also confers some resistance to stressors, such as heat. Glucose, on the other hand, shortens the C. elegans lifespan overall, but has a complex effect on stress resistance. When exposing C. elegans to heat stress, the daf-2 mutant animals are predicted to have greater stress resistance than wild-type, but those daf-2 C. elegans in glucose media are expected to have lower stress resistance than those without glucose. Our results supported this hypothesis. Additionally, we found that while the wild-type worms have shorter lifespans than daf-2 worms, as expected, those wild-type worms with glucose had higher resistance to heat stress than without glucose. This was especially noticeable if the worms were stressed on the first day of adulthood. Exposure to heat stress later in life can diminish the advantage of providing glucose during the stress. While small amounts of certain stressors, including heat, dietary restriction, and reduced insulin signaling, can provide a hormetic effect, larger amounts of these same stressors will cause the worms to die off faster. Heat stress of the animals at different ages showed that the combination of heat stress with downregulation of insulin signaling has diverse effects at different ages of the animals. Continuation of this project should look more specifically at larval, early adulthood, middle-ages, and 'old' animals.

Phylogeny Test of Single Copy Genes in Tribe Astereae

Shelby Clark
Faculty Mentor: Richard Noyes

The Astereae is one of the largest tribes of Asteraceae (Compositae), comprising approximately 222 genera and 3100 species. Evolutionary relationships in tribe Astereae have traditionally been estimated using morphology. More recently, analysis of DNA sequence variation from diverse sources such as sequences of the internal transcribed spacers of nuclear ribosomal DNA (ITS of nrDNA), chloroplast gene sequences, and sequences from low copy number nuclear genes have become routine. For tribe Astereae, estimates of phylogeny have been generated using ITS (nrDNA) sequence, and also using whole genome chloroplast sequences. Interestingly, these two phylogenies differ significantly in terms of depiction of relationships and evolutionary trends in the tribe. The objective of this research is to produce an independent phylogeny of tribe Astereae using sequence for 12 key taxa for the putative single copy gene serine hydroxymethyltransferase (SHMT). The resulting phylogeny provides an independent test of the ITS and chloroplast phylogenies and will help to better understand evolutionary relationships in the group and the biogeographical history of Asteraceae in North America.

OCT4 and NANOG Expression in Human Fibroblast with Short Telomeres

Ethan M Clement
Faculty Mentor: Calin Marian

Cellular senescence denotes the biological aging of the cell due in part to the shortening of telomeres. In somatic cells, during normal chromosomal replication, the lagging DNA strand is not continuously replicated like the leading strand. This phenomenon, known as the end replication problem, leads to gradual telomere shortening after each cell division. In some normal actively proliferating tissues (such as skin, gut lining, hair follicle, etc.) as well as majority of cancer cells the end replication problem is solved by telomerase, a specialized enzyme that has the capacity to add telomere repeats to the end of chromosomes. Telomerase has two components, the RNA template (hTR) and the reverse transcriptase (hTERT). The re-activation of telomerase has been widely regarded as playing a vital role in the immortality of cancerous cells. Recently, telomerase inhibitor drugs have been shown to induce critical telomere shortening in various cancer types. Our major interest is to investigate the impact of these critically short telomeres on cancer cell and human fibroblast functions, specifically on self-renewal pathways mediated by OCT4 and NANOG transcription factors.

Adaptive Differentiation in Morphology after Colonization of Novel Environments

Ian T. Clifton, and Jeremy D. Chamberlain
Faculty Mentor: Matthew E. Gifford

When a species colonizes a new environment there are likely to be phenotypic changes associated with the colonization. These phenotypic changes are driven by novel environmental pressures unique to the newly inhabited areas. We studied the response of diamond-backed watersnake (Nerodia rhombifer) to colonization of novel environments with different prey regimes than the "ancestral" environments. Feeding morphology is likely to be influenced by prey size, especially in gape-limited predators where selection is limited in its ability to act. While N. rhombifer typically occupy natural areas such as rivers, sloughs, and oxbows, they have also colonized man-made fish farms. These farms tend to specialize in the types of fish they produce with some farms raising large-bodied fish and others raising small-bodied fish. Our study suggests, counter to expectations, that while differences exist between populations prey size has no predictable influence on relative size of feeding structures. We provide three potential explanations for the absence of a predictable pattern among populations.

Western Spruce Budworm Herbivory Influences Macroinvertebrate Stream Food Webs

Elise Coffelt, Garrett Frandson
Faculty Mentor: Sally Entrekin

Western Spruce Budworm (WSB) outbreaks are predicted to increase in frequency and severity within Douglas fir riparian zones as climate changes. With increased global temperature, Douglas fir habitats expand northward, which will open new areas to WSB herbivory. Intense and extensive herbivory could alter stream resource and habitat availability through increased defoliation and resultant decreased canopy cover and frass addition. Douglas fir dominates coniferous forests in Washington State where fir needles provide organic nutrients to oligotrophic headwater streams. Microbial and macroinvertebrate consumers break down needles slowly; however, WSB fir needle consumption and subsequent excretion accelerates breakdown, increasing nutrient availability to in-stream organisms.

We predicted WSB herbivory would change aquatic macroinvertebrate communities in three ways, as reflected by changes in macroinvertebrate abundances. First, increased light availability and resultant primary production stimulate scraper taxa abundance. Second, increased nutrients from frass leaching stimulate heterotrophic biofilm growth and increase shredder taxa abundance. Last, increased frass-derived particulate organic matter increase collector- and filterer-gatherer taxa abundance. We compared macroinvertebrate communities in one stream with WSB herbivory and another without and estimated food source contributions using natural abundance of stable isotopes. Carbon, nitrogen, hydrogen, and oxygen ratios in organic matter allow direct identification of frass in biota. The presence of frass indicates WSB herbivory as a cause for variance in macroinvertebrate communities between the two streams.

Preliminary data show no difference in macroinvertebrate community composition between the two streams. Both streams supported predominantly collector-gatherer, predator, and shredder taxa. However, the dominant predator, Rhyacophila, and two collector-gatherer taxa, Chironomidae and Baetidae, show frass signatures in the WSB stream. Frass may be an important resource for gatherers that also support higher trophic levels in these streams.

Possible Hybridization Between Claytonia Virginica and Claytonia Ozarkensis

Landon B. Gatrell
Faculty Mentor: Katherine C. Larson

Claytonia ozarkensis is restricted to growing in the Ozark region on sandstone bluffs where it grows from horizontal cracks in the sandstone layers or on rock shelves. At one C. ozarkensis site on a sandstone bluff within Cove Creek Natural Area, ANHC, Arkansas, the widespread Claytonia virginica is found growing nearby as well as what appears to be an intermediate form. Overlap of habitats between Claytonia virginica and Claytonia ozarkensis might be leading to hybridization between the two species. One distinct characteristic of C. ozarkensis is its long pedicels and their tendency to recurve to face the bluff wall as seeds develop. Through observations we examined the pedicel movements of both C. ozarkensis and C. virginica, as well as the possible hybrids. The movement of C. ozarkensis pedicels resulted in 63% of seed capsules facing the bluff while only 18% of the seed capsules on the hybrid form faced the bluff wall. All seed capsules of C. virginica face the ground. A survey of three habitats at the bluff showed that rock shelves were colonized mostly by ozarkensis, but the possible hybrids also favor this habitat over the ground and the wall cracks. The ground beneath the bluff contained virginica, while cracks in the bluff contained ozarkensis.

OVX-Induced Reduction of Mechanical Strength in the Tibias of Young Mice

Charles Deckard
Faculty Mentor: Brent Hill

Osteoporosis is characterized by reduced bone strength and is often associated with postmenopausal women and age-related estrogen deficiencies. However, there are conditions when women experience depleted estrogen levels prior to menopause, for example, it is common for women to undergo ovariectomy (OVX) surgeries as a treatment or preventative measure against ovarian cancers and diseases; also, individuals born with aromatase deficiencies lack the ability to produce adequate levels of estrogen. Previous data suggests estrogen deficiencies in pre-menopausal women are linked to reduced bone volume and mineral density, but little research has been done, to our knowledge, on how estrogen deficiencies impact the overall quality of bone in young individuals over time. In our study, OVX induced estrogen depletion in mice served as a representative model for young females. We subjected 2 month old mice to OVX (n= 25) and SHAM (n= 34) surgeries and evaluated the treatment effects on overall bone quality using three-point bending, bone-dimensional measurements, E2 levels, and body and uterine weights at periods of 2, 4 and 8 weeks post-surgery (n= 4-16). We found the max load and stiffness of OVX mice tibias were significantly weaker than SHAM mice tibias at 4 and 8 weeks post-surgery. OVX tibias withstood significantly lower levels of stress than SHAM tibias across all age groups, while elasticity was only found to be higher in SHAM mice at 8 weeks post-surgery. Additionally we detected significant physiological effects of surgery and aging on body weight, uterine weight and E2 levels. Our study demonstrated the importance of E2 in maintaining healthy bones in young females.

The Role of the Ecological Niche in Lineage Diversification of Queensnakes, Regina septemvittata

Derek Filipek
Faculty Mentors: Don Shepard, Ginny Adams

The reduction in gene flow that facilitates population divergence and speciation can be due to ‘hard’ barriers such as rivers and mountains or ‘soft’ barriers such as variation in environmental conditions. Hard barriers are typically obvious physical features of the landscape that impact a large number of species similarly whereas soft barriers are more difficult to detect and may be species-specific. Ecological niche modeling is often used to characterize and compare the niches of different species or populations. These methods also provide a means to determine whether divergence is associated with soft barriers to gene flow and to examine patterns of niche evolution. We used freshwater environmental data layers to generate ecological niche models (ENMs) in Maxent for the four geographically distinct evolutionary lineages within the Queensnake, Regina septemvittata. We used ENMTools to determine if geographic boundaries between lineages were associated with abrupt environmental changes as would be predicted by the presence of a soft barrier to gene flow. We also used ENMTools to test whether niche conservatism or niche divergence has played the more prominent role in promoting and maintaining lineage divergence. ENMs showed that the region separating the disjunct Arkansas population from populations east of the Mississippi River has low suitability. Geographic boundaries between lineages varied in their degree of environmental change with some supporting the presence of a soft barrier; the existence of hard barriers was also evident. Environmental niches differed among lineages, indicating niche divergence has played the prominent role in lineage divergence.

The Effects of Two Gray of Radiation on Mice Aorta

Quinton Kaufman
Faculty Mentor: Brent Hill

In todays era one of the leading causes of death is cardio vascular disease. There has been an association with radiation making a person more at risk for heart disease via high blood pressure, yet the cause at this point has been undetermined. We suspect this is due to radiation interfering with various calcium transporters inside of the cell. In this study rats were obtained that had been exposed to 2 Gray of radiation, which was meant to mimic space radiation, but is similar to the radiation that is absorbed during medical procedures such as an abdominal CT scan. A western blot analysis was performed on the smooth muscle cells of the aorta in order to determine the effects of the radiation. Western blot is a procedure which measures the levels of protein in a sample. The protein chosen for the focus of the research is SERCA (Sarco/endoplasmic reticulum calcium ATPase). This protein is one of the main proteins that removes calcium from the cytosol of the cell and stores it in the sarcoplasmic reticulum where it is held to prevent its accumulation in the cytosol. If left unchecked, accumulation in the cytosol would cause an increase in blood pressure.

E-cadherin Expression in Prostate Cancer Cells is Modulated by Adhesion Status

John A. Martindale
Faculty Mentor: Calin O. Marian

Imetelstat is currently being evaluated in clinical trials as a treatment against some of the most lethal forms of cancer. Imetelstat displays a two-pronged attack on cancer cells. It acts as a competitive inhibitor of telomerase, a cornerstone enzyme in cancer cells; telomerase inhibition leads to progressive telomere shortening and ultimately apoptotic death. A secondary attribute of imetelstat is the morphological affects it has on cells rendering them incapable of adhesion to a substrate. This lack of adhesion has been hypothesized to prevent the transition of cancerous cells from benign to metastatic. Though the telomerase inhibitor function of imetelstat was well studied, the significance of adhesion loss is largely unknown. This process must be fully understood before imetelstat can be approved as an anti-cancer drug.

Some studies have been conducted on the loss of adhesion phenomenon to establish a relationship between imetelstat and specific cytoskeleton components. A recent study suggested a link between the loss of adhesion and E-cadherin, a transmembrane glycoprotein that plays an important role in cell to cell adhesion. This study determined that treatment with imetelstat correlated with a down-regulation of E-cadherin. However, E-cadherin expression may change as a result of lack of attachment to the substrate. Through our testing we hope to determine whether the down-regulation of E-cadherin is a direct result of the drug or simply a secondary response to growth in suspension. By performing tests which analyze E-cadherin levels in three prostate cancer cell lines grown in suspension we hope of establishing a mechanism by which lack of adhesion takes place.

Role of Cadherin 18

Scotty McKay
Faculty Mentor: Calin O. Marian

Cadherins are calcium dependent cell adhesion proteins that are generally located on the cell membrane. Type 1 Cadherins, which are much more well-known than type 2, play a large role in cell-cell adhesion. Type 2 Cadherins, however, lack the HAV coding region present in type 1 Cadherins which plays a critical role in the cells adhesion functions. Prior research has suggested that type 2 Cadherins may play major roles in cancer development as well as early morphogenesis, however this has yet to be confirmed. By learning more about the roles that these different type 2 cadherins play in the body, we could bring about very important discoveries involving bodily processes and disease development. The protein that we are specifically interested in is a type 2 cadherin known as cadherin 18. We will begin this project by looking at the cellular distribution of cadherin 18 in human embryonic kidney cells. These cells were engineered to over-express this protein as well as GFP tag. We will then examine how these proteins interact with other proteins using techniques such as immunocytochemistry, immunoprecipitation, and mass spectroscopy.

Sex-specific Variation of Weapon Size in the Crayfish, Orconectes palmeri

Brandon Meek
Faculty Mentor: Matthew Gifford

In the crayfish species Orconectes palmeri winners of antagonistic interactions are often determined by the ability of the crayfish to accurately display its fighting prowess. However, in some species of crayfish it has been found that chela size is not directly proportional to another important fighting characteristic, pinching force. We hope to determine if chela size is directly related to the pinching force in O. palmeri and whether this relationship depends on an individual's sex. Similarly, we hope to determine the relationship between chela size and swimming speed, another characteristic vital to survival. Eleven male and ten female O. palmeri were sampled from local streams. Chela size was determined by photographing the left and right chelae of every individual, and measurements were taken from each individual using Image J. A principal components analysis was used to generate a single measurement score from the multivariate data as a metric of chela size. The force exerted by the closing of each chela was measured using a custom-built bite force meter that displayed a change in voltage that could then be converted into maximum pinching force in Newtons. The relationship between chela size and chela force for each sex was determined independently using linear regression analysis. Finally, swim speed was measured by tracking crayfish movement in slow motion videos using the video software Savra Master. Our data indicate that there is a generally positive correlation between chela size and grip force in males but not in females. We found that there was a negative correlation between chela size and swimming speed in males but not in females. In addition, the presence of large chelae in males, which might be advantageous in mating, could reduce survival of these males by compromising their ability to escape predators.

A Novel Approach to Quantifying Melanism in the Red-Eared Slider Turtle (Trachemys scripta elegans)

Lori H. Monday, Alex Ano
Faculty Mentor: W.B. Cash

A common technique used for scoring melanism in freshwater turtles uses a subjective quantification scale based on 0 (no melanism), 1 (in between 1 and 2), and 2 (full melanism). Lovich et al. (1990) proposed that photographs of the turtle surfaces could be used to measure melanism. In our study, we used a standardized photographic process and image-processing software package (ImageJ) to quantify the relative proportion of melanic expression on the plastron in slider turtle. The plastron of each turtle was lightly cleaned and photographed in a light box with standardized lighting. Images were white balanced prior to uploading to ImageJ. Plastron images were analyzed for total proportion of melanic pigment. Mean male plastron melanism was 0.53 ± 0.03 SE and mean female plastron melanism was 0.57 ± 0.03 SE. There was no significant difference in proportion melanism between males and females (p-value = 0.174). A subset of turtles was analyzed for pre-scute and post-scute shed. Mean melanism proportion was 0.77 ± 0.06 SE for pre-scute shed and 0.50 ± 0.07 SE for post-scute shed. There was a significant difference in proportion melanism, such that post-scute shed turtles had proportionally lower melanism (p=0.040). This novel method provides a more objective quantification of melanism in slider turtles and an overall value reflecting the degree of melanism of individuals. These data will be used to compare the progression of melanism in individual turtles over time. This study is part of a larger study addressing melanism and important endocrine correlates of melanin production.

In the Trenches: Do Cabbage Loopers Need Saliva to Trench?

Alex Moore
Faculty Mentor: David Dussourd

Cabbage loopers (Trichoplusia ni) are major caterpillar pests of several crops including cabbage and lettuce. Prickly lettuce (Lactuca serriola), a close relative of cultivated lettuce, poses a formidable challenge to loopers and other herbivores due to elongate secretory cells called laticifers. Damage to the laticifers causes the immediate discharge of toxic, adhesive latex directly onto the mouthparts of the herbivore. To combat this, the cabbage looper uses its mandibles to chew a shallow trench across the leaf. The trench severs the laticifers and isolates the distal section where the caterpillar feeds. The goal of our experiment was to determine if saliva facilitates trenching. In other caterpillar species, saliva released during feeding prevents plant defensive responses. Cabbage loopers in the final instar were randomly assigned to one of four treatments: live plants with intact caterpillars, live plants with spinneret-cauterized caterpillars, excised leaves with intact caterpillars, and excised leaves with spinneret-cauterized caterpillars. An ART-E1 electrosurgery unit with a sharpened fine point was used to burn the spinneret. Data were analyzed with a two way ANOVA. Growth was slower on intact leaves than on excised leaves ($p < 0.0001$), which have depressurized laticifers that do not require trenching. However, caterpillar treatment ($p = 0.4702$) and the interaction between leaf and caterpillar treatment ($p = 0.8028$) were not significant. Loopers with cauterized spinnerets grew as rapidly as intact loopers. Thus, saliva does not appear to facilitate trenching.

The Effects of Glucose on the Lifespan of Long-lived Caenorhabditis elegans under Dietary Restriction

Melina Norris and Caitlyn Barthol
Faculty Mentor: Mindy Farris

Diets that are high in glucose have been associated with obesity, type 2 diabetes and cardiovascular diseases, among the leading causes of death in the US. Dietary restriction (DR), on the other hand, has been shown to extend lifespan in diverse organisms, from single-celled yeast to primates. It is unclear, however, how high levels of glucose accelerate diseases and decrease lifespan, or what effects glucose would have on organisms under DR. To study this, the nematode model organism Caenorhabditis elegans was used due to its striking ability to recapitulate physiological functions of humans, as well as its normal lifespan of 2-3 weeks and its small size. C. elegans, like mammals, are susceptible to glucose toxicity. A genetic mutation in a C. elegans gene controlling pharyngeal pumping, eat-2, induces DR, which increases lifespan in this species. The wild-type (N2) and eat-2 strains of C. elegans were used and the lifespan of C. elegans was measured in the absence or presence of added glucose (2.5M). Three days prior to the documented portion of the experiment, eight to ten parent worms of each strain were picked and transferred to fed plates without added glucose. After three days, offspring worms were transferred to normal growth media (NGM) and NGM + glucose plates, 1 day prior to adulthood. Every other day the worms were transferred to new plates of their respective condition, away from new larvae, and the animals were monitored until all worms died. It was predicted that the eat-2 and N2 strains of C. elegans under the effect of glucose would exhibit shorter lifespans than those lacking glucose. When glucose is added, a decrease in lifespan occurs both with and without DR, presumably as a result of glucose's inhibitory effects on the function of lifespan-extending transcription factors, according to previous research.

OVX-induced Expression of Voltage-gated Ca^{2+} Channel β-subunits in Mice Aorta

Krystal Pham
Faculty Mentor: Brent Hill

17β-estradiol (E2), the primary female sex hormone, functions as a vasodilator and plays a significant role in maintaining vascular tone via voltage-gated L-type calcium channel (CaL) regulation. The intracellular component of CaL, the beta subunit (Cavβ) is essential in maintaining the gating properties of these calcium channels through regulation of various cell signaling molecules (G proteins, kinases, GTPases, etc.). In postmenopausal women, E2 levels decline and susceptibility to cardiovascular disease (CVD) increases. Furthermore, recent studies demonstrate various detrimental effects in Cavβ knockout models towards cardiovascular health in postmenopausal women.

Many studies evaluate the expression of individual beta-subunit isoforms, but few study all four isoforms collectively in cardiac tissue. Therefore, the purpose of our study is to understand the mechanisms of CaL, specifically the beta-subunit isoforms 1-4, in maintaining healthy arterial blood pressure. Mice will be menopause-induced via ovariectomy, sacrificed 4-weeks post-surgery, and aortas will be excised and analyzed. This study intends to measure protein level and mRNA expression of each beta subunit in mice aortas after ovariectomy via western blot and qRT-PCR analysis, respectively.

Does Testosterone Mediate a Sexually Dimorphic Signal of Quality?

Christopher D. Robinson
Faculty Mentor: Matthew Gifford

In many taxa, color is used to advertise quality. In general, individuals with larger, more vibrant color characteristics are healthier, are better performers (e.g., run faster, bite harder, etc.), defend relatively larger territories and more resources, and sire more offspring than individuals with smaller, less vibrant color characteristics. In the prairie lizard, Sceloporus consobrinus, males exhibit bright blue abdominal patches that are highly variable in size and color intensity between individuals, suggesting it may be a proxy for quality. These patches develop at sexual maturity when circulating levels of testosterone increase. Testosterone is implicated in influencing several other individual traits as well. In Sceloporus, among other species, testosterone levels are positively correlated with aggression, activity rates, and home range size, while simultaneously decreasing survivorship because of an increased energy expenditure. Despite these relationships, it is currently unknown if color serves as an indicator of quality in the prairie lizard, and if testosterone mediates the potential relationship between color and quality. To test this, I will study two populations of Sceloporus established on islands in Lake Ouachita, which allows me to confidently collect repeated measurements of color, performance, and testosterone on the same individuals throughout the breeding and nonbreeding seasons. To quantify color, I will use a photospectrometer. To quantify performance, I will perform focal observations and quantify endurance and bite force. I will also count number of offspring sired by each male to assess fitness. To quantify testosterone, I will collect blood samples and use a Testosterone ELISA Kit (funding by CNSM). I will then use path analysis to analyze the relationships between color, performance, and testosterone. This study will be the first of its kind to assess the overall relationship between morphology, performance, physiology, and fitness in Sceloporus, and help us understand how females choose the highest quality mates.

Upriver Population Characteristics of the Ohio Shrimp, Macrobrachium ohione, in Arkansas

Geoffry Spooner
Faculty Mentors: Reid Adams
Lindsey Lewis, US Fish and Wildlife Service, Conway Field Office, Arkansas

The Ohio shrimp (Macrobrachium ohione) is amphidromous, where marine habitats are required for early juvenile development, but other life stages are able to be completed in freshwater. In the Mississippi River system, upriver adult habitat historically included the Ohio River and Upper Mississippi River, but abundance has reportedly declined, particularly upriver of Louisiana. Migration has been hypothesized to be impacted by dams and channel flow alterations. Current range, abundance, and life history of Ohio shrimp are relatively unknown upriver of Louisiana. During May-October of 2015, 48 Ohio shrimp were trapped in the lower Arkansas River, eight in the White River, two in the St. Francis River system, and 43 in the Arkansas reach of the Mississippi River. These are the first collections indicating tributaries to the Mississippi River in Arkansas are upriver habitat for Ohio Shrimp. Young-of-year females were more abundant than males, but Age-1 females were rarely caught compared to Age-1 males. Our overall upriver sex ratio was 60% male and 40% female, whereas coastal populations tend to be female skewed. Additionally, four Age-1 females were caught in the White River during late June/early July 2015 that had eggs visible between the swimmerets suggesting downriver reproductive migrations by adult females. Ohio shrimp occur in Arkansas habitats greater than 600 river kilometers from the Gulf of Mexico and show patterns suggestive of downriver female migration to complete the amphidromous life cycle.

Changes in Land Use and Fish Assemblages in Four Ozark Highland Streams over Four Decades

Heather A. Saco
Faculty Mentors: Ginny L. Adams and S. Reid Adams

Long-term studies evaluating land use and fish assemblage structure are often lacking but necessary to further understanding of anthropogenic influence on local fish assemblages. Land use is known to influence aquatic ecosystems and the aquatic biota. Sylamore, Piney, Jane's and Big creeks are in the White River drainage in north central Arkansas. During summers 2014 and 2015, we sampled fishes at 39 sites across the four drainages. Sites, dates, and sampling methodology were consistent with previous data collected during the 1970's. We used the NWALT dataset to determine historic (1974) and current (2012) land use for all systems. Fish assemblage persistence and stability were calculated for each site sampled and analyzed in relation to catchment land use. Persistence was highly correlated with percent land use across all systems (forest rho=0.46, pasture -0.45, urban -0.52). In addition, stability was significantly correlated with percent forest (0.43) and pasture (-0.41) across all systems. Seven species showed significant range expansions across all four systems, and one range reduction was detected in Micropterus dolomieu (reduced from 20 to four sites). At sites where Micropterus dolomieu was missing in the current collection, we observed colonization of Micropterus punctulatus and M. salmoides. An apparent downstream shift of headwaters species, Semotilus atromaculatus and Chrosomus erythrogaster, was detected in two of the systems and suggests a change in upstream hydrology. In-stream habitat reflected changes in land use and may provide proximate factors that explain the correlation between assemblage shifts and land use.

How Does Urban Intensity and Orientation Change Stream Water Quality?

Stephanie Stoughton
Faculty Mentor: Sally Entrekin

Urbanization changes hydrology and nutrient-loading to alter the amount and form of material and nutrients transported throughout catchments. Runoff from fertilized lawns, parking lots, roads, and wastewater can stress nearby freshwaters by elevating nutrients (e.g. nitrogen, phosphorus) and conductivity. Urban categories (e.g. commercial centers, residential areas) are expected to exert varying stress on freshwater based upon their extent and density within a catchment. The magnitude of stress could also depend on the orientation of urban categories to freshwater. When categories are close to stream channels, shorter flow paths reduce the potential for retention or biological-processing. In small catchments (<25km^2), categories are close to stream channels regardless of their orientation within catchments. We hypothesized catchment-level land use would explain variation in nutrient and sediment variables better than land use within 200m of streams because catchments are small with categories close to streams. We sampled sediment and nutrient concentrations in 10 streams representing a gradient of urbanization. Preliminary data support our hypothesis because total phosphorus (Pearson's $r = 0.664$, $p = 0.036$), soluble reactive phosphorus (Pearson's $r = 0.692$, $p = 0.027$), and total suspended solids concentrations (Pearson's $r = 0.490$, $p = 0.028$) were significantly correlated with catchment-level urbanization, but not with urbanization within 200m of stream channels. We also hypothesized commercial land use would explain more variation in nutrient and sediment variables than residential land use because commercial areas are more impervious and heavily trafficked. Our hypothesis was not supported because commercial land use did not have significant relationships with nutrient data. Preliminary results suggest phosphorus may be entering stream channels adhered to sediment because both total suspended solids and phosphorus concentrations were positively correlated with catchment-level urbanization.

Using Genomics Approaches to Study Formation of Nodule-like Structures in Rice

Jackie Thomas, Hamilton Newhart, Ashley Spurr, David Zimulinda, Ha Ram Kim, Andres Vega
Faculty Mentor: Arijit Mukherjee

Legumes can develop a symbiotic association with soil bacteria, rhizobia, that leads to the formation of specialized root structures, nodules, inside which nitrogen fixation can occur. Unfortunately, this symbiosis is species-specific and is restricted only to legumes. Therefore, cereals are heavily dependent on fertilizers for their nitrogen needs. Several studies have shown that plant hormones play important roles during legume-rhizobia symbiosis. For instance, auxins induce the formation of nodule-like structures (NLS) on legume roots in the absence of rhizobia. Furthermore, these NLS can be colonized by rhizobia and successful nitrogen fixation can occur inside them. Interestingly, auxin also induces similar NLS in cereal roots. While several genetic studies have identified plant genes controlling NLS formation in legumes, unfortunately, no studies have investigated the genes involved in NLS formation in cereals. In this study, we were successful in inducing NLS in rice roots, using auxin, 2,4-D, consistently at a high frequency (>90%) under controlled sterile conditions. These structures were characterized by a broad base, a diffuse meristem, and increased cell differentiation in the vasculature. Next, we performed a comprehensive RNA-Sequencing experiment to identify the differentially expressed genes during NLS formation in rice. We identified several interesting genes based on their biological and molecular functions and we validated the expression pattern of several genes using RT-PCR. We show that NLS formation is independent of nitrate concentration. We have also initiated a forward genetic screen to identify mutants affected in NLS formation. Future efforts will focus on characterizing the genetic pathway controlling the formation of these structures, their colonization by different nitrogen-fixing bacteria, and more detailed studies on the developmental pattern of these structures. These studies will make important advances towards improving nitrogen fixation in cereals and will benefit agriculture.

FtsZ Homolog, FszB's Role in Dictyostelium Discoideum Mitochondrial Dynamics

Ericka Vogel and Pristine Pittman
Faculty Mentor: Kari Naylor

It is believed that mitochondria were once independent entities, but later were ingested by a cell and eventually became an essential part of that cell—for it provided a major source of ATP. As more knowledge was acquired regarding mitochondria, scientists learned that malfunctions in mitochondrial dynamics (fission and fusion) contribute to many diseases. In particular, diseases that affect the nervous system like Parkinson's and Alzheimer's. In order to advance this research, it is important to begin with the foundation. While human mitochondria no longer utilize the mitochondrial division associated protein filaments like FtsZ, it does occur in protists—an organism, in regards to cladistics, that is closer to the ancient cell that could have ingested what eventually became the mitochondria. In our model organism, Dictyostelium discoideum, there are two FtsZ homologs, FszA and FszB. These appear to play a role in mitochondrial division in these cells. We plan to identify the rates of fusion, fission, and motility of the mitochondria in cells expressing GFP-FszB and to localize GFP-FszB during fission and fusion events. Once we localize GFP-FszB during fission and fusion, we can identify the role of this protein filament. This work will contribute to our understanding of the evolution of mitochondria as well as insight into the mechanisms that regulate mitochondrial disease.

Assessing Misconceptions of Evolution Among Students Enrolled in Freshman Biology Courses at the University of Central Arkansas

Shonqualla West
Faculty Mentor: Mark Bland

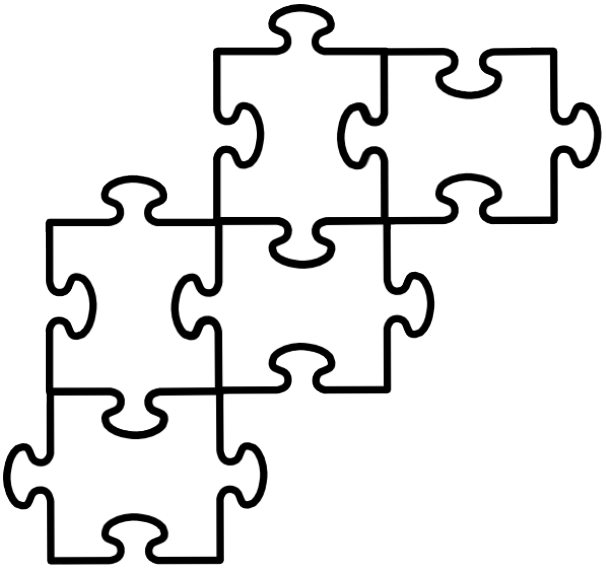
Evolution is one of the most contentious scientific topics of modern society. Studies have revealed that societal pressures resulting from this controversy have not only caused science teachers to de-emphasize the topic of evolution, but to eliminate it from science classes in schools across the United States. Evolution is the unifying theme of biology that should be emphasized in science curricula. If evolution is not taught, students will lack the level of scientific literacy needed to be successful in college and beyond. The purpose of this study was to examine whether misconceptions held by students enrolled in freshman level biology courses at UCA differed between non-science majors and science majors. A survey with 25 Likert-scale items was administered to students enrolled in 5 freshman level biology courses (three non-majors classes and two majors classes). The surveys were scored and stratified based on non-majors vs. majors. An ANOVA test was performed on the data to assess whether there was a statistically significant difference between misconceptions of students enrolled in non-majors and majors biology courses. Additionally, a t-test was utilized to confirm the statistical significance of the ANOVA test. The non-biology majors had a mean score of 77 out of 120 points on the survey, which was significantly lower than the science majors with a mean score of 82. Given these results, there is significant statistical evidence to suggest that non-science majors were less competent in evolutionary theory compared to science majors ($p < 0.0005$, alpha = .05). The results from this study can be used to promote awareness of and knowledge about evolution in high schools for all students.

Investigating the Role of the Dynamin-like Proteins (Dlps) in the Mitochondrial Dynamics of Dictyostelium discoideum via Cytoskeletal Disruption

Nicholas West
Faculty Mentor: Kari Naylor

Mitochondria are dynamic organelles, hypothesized to be derived from an ancestral symbiosis between free-living prokaryotes, which eventually gave rise to eukaryotic cells. These organelles perform vital metabolic functions such as oxidative phosphorylation to form ATP for cellular energy; programmed-cell death for cell maintenance, development, and differentiation; and the regulation of calcium ion storage for cellular pathways. Their tubular structure and, thus, their functional capabilities are maintained through the dynamic processes of fission and fusion. Proteins embedded in the inner and outer mitochondrial membranes are primarily responsible for these events. Adapter proteins, proteins related to the dynamin superfamily (DRPs), and the actin and microtubule cytoskeleton are associated with the regulation of mitochondrial morphology. Disruption of mitochondrial morphology is strongly related to dysfunction of the organelle itself, which has been strongly linked to various neurodegenerative diseases, cardiovascular diseases, and complications related to diabetes.

In our research, we are investigating the role that the dynamin-like proteins (Dlps) play in regulating mitochondrial morphology, fission, fusion, and motility through the disruption of the actin and microtubule cytoskeleton. We collected 50 cells from the wild-type AX4 and the mutant dlpA- strain of Dictyostelium discoideum, in order to quantify the morphology of the mitochondria and the cytoskeleton when treated with the drugs Latrunculin B or Nocodazole which are designed to depolymerize the actin and microtubule cytoskeleton, respectively. We also examined fission and fusion events as well as mitochondrial motility in 30 cells of AX4 and dlpA- for treated and untreated cells. Our preliminary results indicate that DlpA plays a role in regulating the actin cytoskeleton and fission and fusion are upregulated. This work will provide additional characterization of the dynamin-like proteins and the relationship they have with the mitochondria and cytoskeleton.



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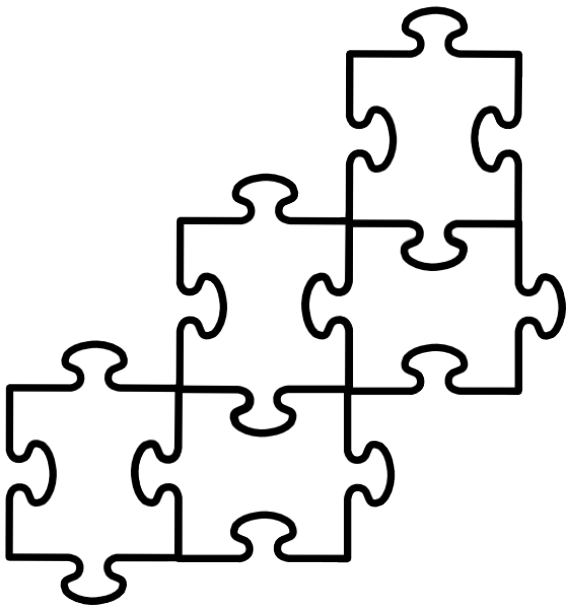


Iron Heteroscorpionate Complexes

Kat Demaree
Faculty Mentor: Patrick Desrochers

Scorpionates are aggressive tridentate chelates with broad applications encompassing nearly every metal ion on the periodic table. Heteroscorpionates (where one of the three nitrogen donor groups is varied) introduce interesting asymmetry in the complexes prepared. The heteroscorpionate Tp' (Inorg. Chem. 2011, p. 1931) was developed in our lab following a simple pyrazole-for-triazole substitution strategy. Tp' represents the scorpionate chelate hydrobenzotriazolyl-bis(3,5-dimethylpyrazolyl)borate, a monoanion. For the present work, new iron complexes, $(Tp')_2Fe^{n+}$, will be described. The iron(II) form (n=0) and iron(III) form (n=1, as its BF_4^- salt) of the ligand were synthesized, both of which have been characterized by paramagnetic ^{11}B NMR as well as through infrared and electronic spectroscopies. The orange iron(II) form has been oxidized chemically to the deep purple iron(III) form, and both have been separated into cis and trans isomers. These reactions demonstrate the utility of this scorpionate with earlier transition metals—presently only late metals have been employed (nickel and copper) with Tp'. Iron and still earlier metal ions introduce interesting redox and magnetic properties.

Synthesis of Amino Acid Radical Precursors

Candice Foscue and Daniel Shrum
Faculty Mentor: K. Nolan Carter

Biomolecules are subject to damage by reactive oxygen species such as hydroxyl radical. This process has been implicated in aging and disease. 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 non-specificity, studying the role played by specific radical intermediates in protein damage is difficult. To facilitate the study of this process, we are synthesizing compounds that produce specific amino acid radicals upon exposure to UV light. Whereas hydroxyl radical 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 Studies toward the synthesis of these photolabile precursor compounds will be described.

Microwave-assisted synthesis of KTp* and the corresponding Ni Complex as an Undergraduate Inorganic Chemistry Experiment

Emily Helm
Faculty Mentor: Richard Tarkka

Scorpionate ligands, such as hydrotris(3,5-dimethylpyrazolyle)borate, (Tp*), are very common in the inorganic chemistry literature, but are not usually made or used in undergraduate level inorganic chemistry teaching labs. This is probably because the synthesis of KTp* from KBH_4 and 3,5-dimethylpyrazole is prohibitively time consuming. We have developed a simple procedure for synthesizing a KTp* using a microwave technique. The simplicity of the technique allows for the synthesis KTp*, along with the preparation of the two ligand product, $(Tp^*)_2Ni$, in about one hour forty minutes. In a typical three-hour teaching lab block, this allows the complex to be characterized by ^{11}B NMR spectroscopy or other techniques, such as UV-Vis spectroscopy. This technique can be incorporated into current curricula to further the knowledge of scorpionate ligands.

Surface Enhanced RAMAN Spectroscopy on Optimized AgAu Nanoparticles

Taylor Huntington
Faculty Mentor(s): Donald Perry and Jingyi Chen

This laboratory is investigating surface chemistry of hollow nanoparticles constructed from Ag and Au. The goal of this investigation is to develop optimal AgAu nanoparticles for 633 nm surface-enhanced RAMAN and IR spectroscopy (SERS/SEIRA). The formation of the hollow nanoparticles is through the galvanic replacement reaction. The changes of localized surface plasmon resonance from solid to hollow nanoparticles are monitored by UV-vis spectroscopy. Different amounts of Au exhibited different wavelengths in the UV-vis. The hollow nanoparticles are subjected to one of two methods. The initial reaction between the hollow AgAu nanoparticles and rhodamine in acetone is investigated through SERS mentioned above, and multiple layers of rhodamine solution on the substrate are monitored using SEIRA.

University of Central Arkansas ACS student chapter: Integral component of our department

Taylor Huntington, Rachel Mayo, Jessica DeYoung, Haley Kay
Faculty Mentors: Faith Yarberry, Kristin S. Dooley, Karen L. Steelman

Our ACS Student Chapter plays a major role in the integration of students into the UCA Chemistry Department. Our chapter serves the department via on-campus expos for the student body (RSO Fair, Major's Fair, Conway Daze) as well as attending high school recruitment days to meet prospective students and their parents (Bear Fairs). We provide community outreach via chemistry demonstrations and hands-on activities with youth at local schools (Science Nights), home football games (Kid's Club), and community events (EcoFest). We are able to connect with our community on a personal level by representing our department with pride. Our members are at home in our department because they engage in service, professional development, and social experiences. Additional activities include seminars and luncheons with potential employers and alumni as well as organizing "Program-in-a-Box" webinars. As members, we support each other through social networking opportunities with other students and departmental faculty. Active involvement provides a holistic experience that prepares us for the future.

Measurement of Aerosol Optical Properties Using Pulsed Laser Cavity Ring-down Spectroscopy (CRDS)

Amanda Jarman, Haley Kay, and Justin Land
Faculty Mentor: Kristin S. Dooley

Because aerosols can interact with light in various ways due to their size, composition, and chemical structure, they may contribute to a warming or cooling effect on the climate. Current climate models often struggle to accurately predict the effects of particles because the theoretical light interaction calculations are based on particles that are ideal spheres of a single component which is either purely absorbing or completely scattering in nature. While this model works well for some aerosols, others that are multicomponent or aspherical are often not described well; a challenge which introduces uncertainty in predicting their contribution to climate modeling. Correcting the models highlights the need for more detailed optical measurements of non-ideal particles.

Cavity ring-down spectroscopy (CRDS) is an optical absorption technique that has been used as an effective technique for measuring the optical properties of aerosols. The focus of the current project is the implementation and characterization of a CRDS system capable the optical measurement of laboratory generated aerosol particles. The particle generation is capable of producing particles of various sizes made from different combinations of scattering and absorbing materials to produce a wide variety of multicomponent particles. Optical properties of the generated particles measured using the CRDS system can then be compared to theoretically predicted values in order to suggest mathematical correction methods that can be used to aid current climate models.

Synthesis and Characterization of Novel Fluoro-bridged Copper(II) Complexes

Bryce Johnson
Faculty Mentor: Lei Yang

The fluorinated organic compounds are very attractive in pharmaceutical and agrochemical disciplines due to their unique thermal stability, solubility and reactivity, but the insertion of fluorine atoms remains as a great challenge. Recently, fluorination of organic substrates mediated by copper catalysts received considerable attention because of the regioselectivity, less harsh reaction conditions and better efficiency. Research results have indicated the high-valent copper-fluoride intermediates could be involved in the catalytic process. In our effort to better understand the possible catalytic mechanism, we used Cu(II) and Cu(I) complexes supported by a simple diamine ligand to react with fluorine reagents. Interesting fluoro-bridged copper clusters were isolated and characterized by X-ray crystallography, UV-vis, EPR and FT-IR. The reactivity of these clusters and possible intermediates of the reactions are currently under investigation.

Comparison of Experimental Aerosol Optical Properties to Mie Scattering Theory of Multi-component Aerosols

Justin Land, Amanda Jarman, and Haley Kay
Faculty Mentor: Kristin S. Dooley

Accurate measurements of the optical properties of aerosols are needed in order to quantify the effects that aerosols have on climate change. While Mie scattering theory is capable of accurately modeling the interaction of light with spherical, single-component, non-absorbing aerosols, various methods must be used to correct the calculation when multi-component, absorbing aerosols are modeled. Cavity Ring-Down Spectroscopy (CRDS) is an optical absorption technique that is ideal for measuring extinction coefficients as well as scattering and absorption parameters for atmospheric aerosols. After characterization of the pulsed CRDS system at $\lambda = 532$ nm with various sizes of polystyrene spheres, optical data from laboratory generated multi-component aerosols are compared with predicted Mie scattering modeling of aerosols. Various correction techniques are applied to the calculation to determine ways to more accurately model multi-component aerosols. Because most atmospheric aerosols are multi-component, a better understanding of how to theoretically treat them will lead to more accurate models of real-world aerosol interaction with light.

Expression and Purification of the Calmodulin Binding Partner PEP-19

Christian Mitchell, Colton Crain
Faculty Mentor: Tori Dunlap

Calmodulin (CaM) is a calcium-sensing protein that plays a significant role in regulating enzyme activity. Oftentimes, CaM binds a disordered protein region and causes it to have an **α**-helical secondary structure. Calcineurin (CaN) is a CaM binding partner that attains this structure in addition to another **α**-helix that forms downstream from the binding site. We hypothesize that proteins with a disordered binding region for CaM that is much larger than the area often observed in CaM substrates might exhibit similar behavior. Therefore, a completely disordered protein might interact similarly. PEP-19 is a small, 50 amino acid, protein that is completely disordered and found in Purkinje cells in the cerebellum. When PEP-19 binds to CaM it increases the rate at which CaM binds and releases calcium, altering calcium binding kinetics. A region in PEP-19 near the N-terminus of the CaM binding region is expected to form an amphipathic **α**-helix when CaM is bound similar to the outcome of the CaM and CaN interaction. To investigate this structural alteration, we made and purified PEP-19 using E.coli and a new method called autoinduction. Autoinduction is a unique method that uses a specific mixture and concentration of glucose and lactose, 5052, to cause the production of PEP-19 to occur without the need to monitor cell growth. The PEP-19 made had a His tag attached, so a Ni-NTA column was used to purify the protein. Purified PEP-19 oligomerizes and is seen as a dimer and trimer; it must be reduced to monomer with the reducing agent DTT. Gel electrophoresis was performed on the pure protein to confirm the purity of PEP-19, and MALDI-TOF MS was used to verify the identity. In the future, we will investigate how PEP-19 will interact with CaM and compare this interaction with that of CaM and CaN.

Synthesis and Characterization of Dynamic Porous Coordination Polymers (DPCPs) Supported by Pyridylamide Ligands

Clement Mugenzi, Ethan P. McMoran
Faculty Mentor: Lei Yang

Absorption and storage of small molecules, such as H_2, N_2 and CO_2, by dynamic porous coordination polymers (DPCPs) have attracted considerable interest due to the high selectivity and efficiency of these materials. In our effort to discover the new generation of DPCPs, we synthesized a serial of pyridylamide ligands functionalized with multiple donors, which are expected to significantly impact the coordination properties to provide different structural features of materials. Recently, various coordination compounds with different nuclearity supported by these pyridylamide ligands have been prepared and characterized by X-ray crystallography, IR, UV-vis and elemental analysis. The interesting structural and spectroscopic features of these compounds will help us obtain a deeper understanding on ligand design and polymer construction, which are major contributors for adsorption properties of DPCP materials.

Impact Analysis from the Incorporation of a Placement Exam Toward Student Success in Freshman-level Chemistry Courses

Jordan Moore, Jaimi Franklin, Haylee Barnes
Faculty Mentor: Faith Yarberry

In 2012, it was reported that there was a direct correlation between student success rates in freshman-level college chemistry courses and the score they earned on the mathematics portion of the ACT exam. The results triggered the Department of Chemistry to adopt a 21 Math ACT score as the pre-requisite for College Chemistry I and General Chemistry for Health Sciences, or a pre-requisite/co-requisite of College Algebra. In 2015, it was reported that student success rates matched the prediction made by the previous research with 80-85% of the students enrolled in College Chemistry I and 85-90% of the students enrolled General Chemistry for Health Sciences passing the course.

Upon further evaluation, it has been determined that the students enrolled in these courses with a Mathematics ACT score of less than 25, were the students that may or may not pass the course. In an attempt to improve the statistics for these students, the Department of Chemistry has instituted an advisory Chemistry Placement Exam. The implication of the exam is that the results will better reflect course readiness of incoming freshman required to take either General Chemistry for Health Sciences or College Chemistry I. During the Summer of 2015, it was recommended that students with a Math ACT score below 26 take the placement exam. Advisors were then better prepared to direct students into the appropriate Chemistry course to set the student up for success. To determine the impact of the assessment exam, since it is strictly advisory at this time, the student population was divided into categories dependent on Math ACT, and if they took the placement exam and the advice provided by the exam. The research described in this poster will report the initial findings regarding student success in their Chemistry courses.

Chemical Analysis of Ancient Paintings: AMS Radiocarbon Dating of Binders & X-Ray Diffraction of Pigment

Sam Petty
Faculty Mentor: Karen L. Steelman

Our laboratory collaborates with archaeologists to study ancient rock paintings. We specialize in using a glow discharge for radiocarbon dating sample preparation. Prior to low-temperature plasma oxidation of organic binders in the paint, we pretreated red and black paint samples with sodium hydroxide solution to remove humic acids. Extracted carbon dioxide was analyzed using accelerator mass spectrometry. Radiocarbon results were averaged using the R_Combine function of the OxCal computer program with IntCal13 curve data to produce calibrated age ranges. We also conducted a mineral analysis on samples using Fourier transform infrared spectroscopy and X-ray diffraction to identify mineral pigments used by ancient artists. These types of chemical results can aid archaeologists in their study of ancient cultures.

The Effect of Retinoid Receptor Agonists on K562 Cellular Adhesion, Proliferation, and α5β1 Integrin Cell Surface Expression

Raynin Phomakay and Madison Lee
Faculty Mentor: Melissa Kelley

Establishment and maintenance of proper immunity requires a precise balance between cellular adhesion and proliferation. A disruption in either event culminates in a variety of pathologies encompassing immunosuppression, auto immunity, and cancer. Retinoids, profoundly affect immune function by mediating cellular adhesion and proliferation in certain leukocytes. Retinoids, by binding to retinoid receptors (RARs or RXRs), modify the expression of a variety of signaling proteins involved in immune cell proliferation and adhesion including, integrins. Integrins are a family of transmembrane heterodimeric receptors consisting of non-covalently linked α and β subunits that are considered to be the principle receptors involved in attachment to the extracellular matrix and provide adhesive interactions that control cellular proliferation. Currently, the contributions by retinoids in immune cell adhesion and proliferation have been independently examined; however, in retinoid responsive immune cell lines there appears to be a potential synergism between cellular adhesion and proliferation, which may be mediated through integrins, specifically the α5β1 subset. In this study, the effect of all-trans-retinoic acid agonists on K562 cellular adhesion, proliferation, and α5β1 integrin cell surface expression was investigated. RARgamma agonist exposure increased K562 cellular adhesion to RGD containing extracellular matrix proteins fibronectin and FN-120 in a time dependent manner. Additionally, cell surface expression of the β1 integrin subunit was increased in the presence of a RARgamma agonist. Interestingly, K562 cellular proliferation levels were decreased in a time-dependent manner when cells were treated with the RARgamma agonist. In the presence of the RARalpha or RARbeta agonists, K562 cellular adhesion, proliferation, and α5β1 integrin cell surface expression was comparable to the vehicle control. Our study is the first to demonstrate that specific RAR agonists alter cellular adhesion, proliferation, and intergrin cell surface expression.

Surface Enhanced Infrared Absorption on Optimized Copper Nanostructures

Morgan Sweere, Taylor Huntington, Will Henry
Faculty Mentor: Donald Perry

The goal of this research is to develop optimal copper metal nanoparticles (MNPs) for applications in surface-enhanced infrared absorption spectroscopy (SEIRA). Various optimized MNPs are formed by oblique angle deposition (OAD) through metal evaporation onto CaF_2 substrates at angles ranging from 75^0 to 80^0. These nanostructures are characterized with AFM, SEM, and UV/Vis-NIR spectroscopy. A monolayer of p-nitrobenzoate ion was deposited onto the copper nanostructures to determine the degree of vibrational enhancement in SEIRA. These optimized MNPs show SEIRA enhancement factors up to x50 better than MNP grown at incident. We observe SEIRA enhancement factors of ~x200 for optimized silver MNPs and enhancement factors of around x100 and x25 for optimized gold and nickel MNPs, respectively. This work will influence a range of biological, medical, catalytic, environmental, and nano-technological applications.

Research Toward the Development and Implementation of an Online Chemistry/Mathematical Tutorial

Enock Rwamuza, Aaron Stebbins
Faculty Mentor(s): Faith Yarberry, Ms. Lisa Christman

College chemistry I and II are freshman-level chemistry courses offered by the Department of Chemistry at the University of Central Arkansas. College Chemistry I is offered as part of the UCA Core and College Chemistry I and II are required by many science majors in the College of Natural Science and Mathematics. According to the literature, Chemistry is frequently considered to be a gate-keeper course for many students. Additionally, the literature, as well as research performed in our group, has shown that there is a direct correlation between mathematical skill and student success in chemistry. Therefore, we believe that the lack of basic mathematical knowledge makes it difficult for students to pass these classes.

The goal of the research is to improve student success on mathematical problems presented in College Chemistry courses through the development of a chemistry/mathematical tutorial. The research presented identifies specific mathematical concepts that students struggle with in College Chemistry I, describes the development of a Chemistry/Mathematical tutorial implemented in this course in the Fall of 2015, and shows the results of the implementation on student success on the mathematical concepts identified. Evaluation of chemistry examination questions from College Chemistry I indicate that students struggle with the inverse relationship and distributive properties. After identifying the specific mathematical concepts, a Chemistry/Mathematical tutorial was developed and implemented in College Chemistry I in the Fall of 2015. Early signs demonstrate improved student performances on the concepts identified.

Calmodulin Induced Conformational Changes in Intrinsically Disordered Protein Regions

Amber D. Rolland
Faculty Mentor: Tori Dunlap

Calmodulin (CaM) is a calcium-sensing protein that plays a critical role in many signaling pathways, regulating enzyme activity according to calcium concentration fluctuations. It has approximately 300 known ligands and is involved in many critical processes, such as smooth muscle contraction, intracellular movement, memory, and metabolism. Alterations in CaM regulation contribute to multiple disease states, such as Alzheimer's disease, Parkinson's disease, and Long QT syndrome. CaM can bind up to four calcium ions, inducing a conformational change that exposes hydrophobic regions which can then bind to a variety of targets. CaM can also bind to regions known as IQ motifs in the absence of calcium. Often the CaM binding region of a protein is disordered and becomes α-helical upon CaM binding. Calcineurin (CaN) is a ser/thr phosphatase that is activated by calmodulin, and its CaM binding region undergoes a disorder to α-helix transition upon CaM binding. Previously published data have shown that disordered residues in the regulatory domain of CaN, outside of the CaM binding region, also gain α-helical structure upon binding CaM and help to remove CaN's autoinhibitory domain, thus activating the phosphatase. It is unknown if CaM also induces order outside of its direct binding region with other ligands. As preliminary work we utilize limited protease digestion and MALDI-TOF to investigate the behavior of CaM binding to its binding regions from several proteins as a baseline for expanding into surrounding regions.

Differences in Water Types in Wells and Springs of the Ozark Plateaus in Northern Arkansas

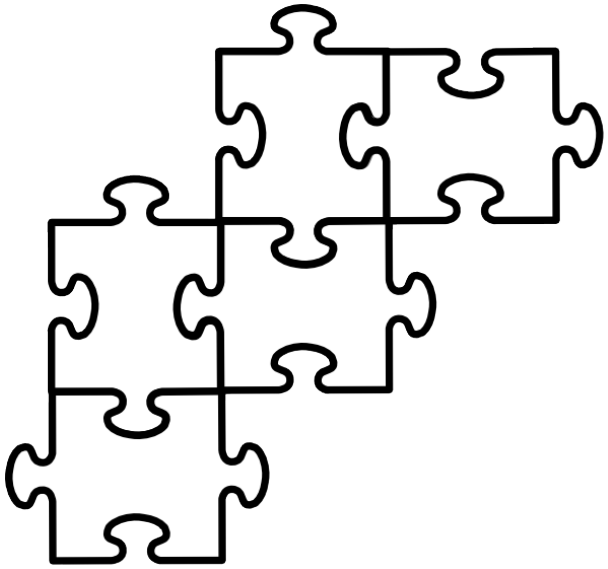
Samantha R. Wacaster, Kristen E. Barré
Faculty Mentors: Kristin S. Dooley, Matthew H. Connolly
Katherine J. Knierim, U.S. Geological Survey, Lower Mississippi-Gulf Water Science Center, Little Rock, Arkansas

Physical (pH, temperature, conductance) and geochemical (major ions) characteristics of groundwater are used to define water types for aquifers within varying geologic regions. Water type can provide hydrogeologic information, such as differences in aquifer materials, rock/water interaction, and changes in redox conditions that occur along groundwater flow paths. This research characterized groundwater geochemistry of three physiographic sections in the Ozark Plateaus of northern Arkansas: Boston Mountains, Springfield Plateau, and Salem Plateau. The region is one of the major karst landscapes in the United States. Large-scale groundwater geochemistry mapping can be used to assess spatial variation across the regions and quantify variation between wells and springs. Aqueous geochemical data were obtained from the National Water Quality Monitoring Council database for groundwater in 13 counties in northern Arkansas that encompass the Ozark Plateaus. Spatial distributions of water types throughout the Ozarks, among different aquifers, and between wells and springs were characterized with Geographic Information System techniques and statistical analyses.

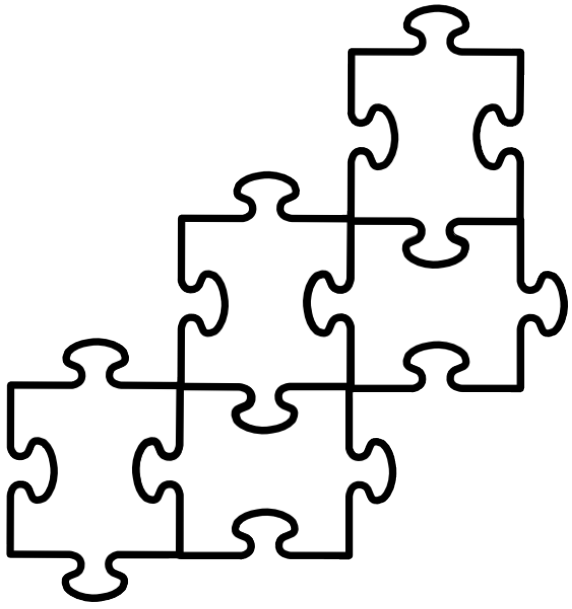
Characterizing the Interactions of Nature-Inspired Polydopamine

Brandon M. Wilde, Taylor E. Huntington, Caleb N. Denton, Morgan D. Sweere, Thomas N. Banh, Bakarie S. Branch, Mary E. Lindsey
Faculty Mentor: Donald A. Perry

Polydopamine (PDA) is a versatile polymer that has adhesive properties which allow it to attach to both organic and inorganic substrates. This characteristic has attracted considerable interest for PDA in multiple disciplines that involve surface chemistry. However, PDA's structure and adhesion mechanism remain elusive. The goal of this research is to characterize the interactions of PDA with its respective binding components by utilizing quantum mechanical calculations and surface-enhanced infrared absorption spectroscopy (SEIRA).



Department of Computer Science



Rate Control for H.265/HEVC Video Compression

Joe Hilton, Reese Childers
Faculty Mentor: Yu Sun

The rapid increasing demand of HDTV and next generation Ultra-HDVT has stimulate the development of a new video coding standard, called “High Efficiency Video Coding (HEVC)/H.265”. However, while the compression methods have improved, the current rate control strategies are developed based its predecessor for H.264/AVC. In this research, we conduct rate control research for HEVC/H.265. Our objective is to develop a new rate controller that will efficiently control the encoding bitrate to meet the channel bandwidth, while obtaining the best available encoding quality. Our proposed rate controller uses an approach that calculates the target bitrate without using a buffer. This is accomplished by calculating the target bitrate through an improved initial target bit estimation, then using a Proportional-Integral-Derivative (PID) bit controller to adjust encoding bitrates. These improvements allow us to remove the buffer, which has been used in traditional rate control algorithms. Removing the buffer will effectively reduce encoding delay and thus improve real time response. To demonstrate the performance of our algorithm, we will compare it to the rate control algorithm adopted by HEVC/H.265.

Complex Event Processing with Esper on Taxi Trajectory Data

Jayalakshmi Kari
Faculty Mentor: Victor S. Sheng

Complex Event Processing (CEP) is being used in business organizations, government organization worldwide. Now a days CEP is mainly used for commercial purpose. There are lot of technologies in place which gives clear idea of what is happening in their business now. But CEP does analyses past data and gives results which would be helpful to improve one’s business on large scale. In this Paper, I focus my learning on analyzing Taxi Trajectory data to draw conclusions such as 1)What is the Peak time 2) Which place does have more visits 3)What is the critical time? In this context Critical Time means when taxis are idle for more time. To work on this paper, I have chosen ESPER open source CEP tool. Implementation language is Java 1.7. Operating System used for this project is Linux.

Using Machine Learning to Catch Unexpected Situations in Complex Event Processing

Sertan Kaya
Faculty Mentor: Victor S. Sheng

The data from multiple sources are gathered which are interpreted more complex circumstances. This creates event pools which does not refer any meaning by themselves. Each event can be independent from each other or it can have a relationship with another event. Each event includes relevant and irrelevant actors. In addition, each event consists of action and reaction as well. Event is supposed to have a starting point and an ending point. The definition of an event can be expanded by the following example.

For instance, a customer books an airline ticket. When the customer gets in the airport which is an event, a security welcomes him where the security is an irrelevant actor, whereas relevant actor is the customer. When the customer checks in, the officer becomes irrelevant other, whereas the customer is relevant actor. All these are called actions, but the reaction does not exist to respond these actions. During the security checking, there is a starting point and ending point. Thus, this is called an event. Check in process is also considered as an event. In case of the cancel of a flight, customers get frustrated. Thus, customers respond this cancellation by their reaction. This is an example of unexpected situation where the reaction arises.

In this CEP project, our goal is to identify events by defining particular rules, and then catch unexpected situations during the complex event processing. Furthermore, by using defined rules, train the machine learning system and expect the system predict and catch unexpected situations.

Educational Robot: LEGO Mindstorm EV3

Min Ji Kim, Yusei Harada
Faculty Mentor: Yu Sun

Nowadays robots for kids are one of the most popular products on the market. Robots with high-end technical features such as app controlling, visual sensors, and voice command will entertain, engage, and inspire kids to learn science and engineering. In this project, we investigate the educational robot –LEGO Mindstorms EV3 by shaping it to different models and building the program using its own sensors and motors. Within this project, our goal is to introduce and demonstrate the LEGO Mindstorms EV3 robot to young students and awaken their learning interest in logic and programming. So far, we have built our robot to Gripper shape in addition to the previous shape Ev3rstorm. We have discovered mobile app control on an EV3 robot of different shapes and developed various programs including beacon-object engagement and object avoidance using an infrared sensor. Currently we working on investigating an easy and simple programming project for young students to learn and play. During our out-reach activities, such as science nights, we found the effectiveness of EV3 as an educational robot. Many of young students were entertained and showed interest about learning and playing with the EV3 robot.

Weighted Ensemble Ground Truth Inference Algorithms

Yaying Li
Faculty Mentor: Victor S. Sheng

In order to increasing the accuracy by one single Ground Truth Inference Algorithm (GTIA), we are finding one way which is Ensemble Learning which is a supervised learning algorithm. In statistics and machine learning, ensemble methods use multiple learning algorithms to obtain better predictive performance than could be obtained from any of the constituent learning algorithms. And it tends to yield better results when there is a significant diversity among the models.

Five Ground Truth Inference Algorithms (GTIAs) we used are Majority Voting (MV), DS, KOS, Zencrowd and RY. MV is the simplest inference algorithm. If multiple classes have the same number of members, the class of the integrated label will be randomly chosen from them. DS models annotators by using confusion matrices in multi-class medical diagnoses. One confusion matrix presents one annotator. KOS was motivated by the reality of differences in labeling quality among different labelers. Zencrowd only uses a binary parameter {good, bad} to model the reliability of an annotator, and it is a little more complex than MV, but simpler than other methods likes DS and RY. RY uses a Bayesian approach to estimate the prior probabilities of the parameters and the positive class. And it models sensitivity (bias towards positive class) and specificity (bias towards negative class) of an annotator.

Multi Target Regression

Sravani Marreddy
Faculty Mentor: Victor S. Sheng

Multi-target regression is concerned with the simultaneous prediction of multiple continuous target variables based on same set of input/predictive variables. When the prediction target variables are binary they are called multi-label classification, while when the target variables are real valued or continuous the task is called as Multi-target regression. In both tasks, target variables often exhibit statistical dependencies and exploiting them in order to improve predictive accuracy. In this paper, a brief introduction of Regression tress and Multi-target regression trees is explained and general regression process using WEKA tool and OLS Regression is explained.

Application of NEAT: Improving an Implementation of NEAT on Super Mario Bros

James Stamps, Winston Biggs
Faculty Mentor: Victor S. Sheng

Combining both neural networks and genetic algorithms have shown great potential to solving complex reinforcement learning problems. In fact neuroevolution, NE, has been shown to be more effective at solving the problems are single pole balancing and robot arm control than Adaptive Heuristic Critic and Q-Learning. One method of NE developed by Kenneth O. Stanley and Risto Miikkulainen, called Neural Networks through Augmenting Topologies (NEAT), is one such method of NE. Unlike other versions of NE, NEAT doesn't just focus on using genetic evolution to solve for the weights but in fact uses genetic methods to find both the weights and the structure of the network.

One application of NEAT would be to build networks that can play video games. A semi-famous YouTube star by the name of SethBling did just that. He designed an implementation of the NEAT algorithm to play Super Mario Bros (NES) and Super Mario World (SNES). This implementation did prove quiet effective at playing the game and beating levels but it did suffer at almost being too simple. When building he only gave the network the vision to see only the most basic version of the screen. It could only determine the difference between enemy and neutral blocks. This proved to be quite effective at beating levels but it seemed almost impossible to beat multiple levels with only one network.

We will change this implementation to allow just one network to beat multiple levels at a time. One possible expansion of his method would be to allow the network to determine the difference between enemy types and to build a layered approach to the network. This combined with redefining the fitness function of the method should result in a better-rounded model that behave more human like.

Gentleness Simulator, Surgical Dexterity Evaluation with Haptic Interfaces

Alexander Yu, Seth Baer, Jake Farmer, Aditya Dendukuri
Faculty Mentors: Tansel Halic

In the evaluation of technical surgical skills, there is a ceiling effect. It is difficult for many of the current evaluation platforms to discriminate the level of skills of potential surgeons after 3 to 4 years. In our study, we built a simulator with a pair of Phantom Omni haptic devices that will assess the dexterity of the trainee. The simulator consists of two tasks. The first is hitting a ball with a racquet to a certain height repeatedly. The second is moving a balloon from one basket to another using tools controlled by the haptic devices. In the simulation the movement of the haptic, the status of the task, and other data related to the task is constantly recorded and will be used to evaluate the skill of trainee. The simulator is currently located at UAMS where two groups: students (novices) and experienced surgeons (experts) will complete the simulations. The data will be collected and analyzed. The goal of this project is to be able to identify medical students who need additional training in surgical skills earlier in the curriculum so that they will have more time to improve the skills that they need in actual surgery.

Complex Event Processing

Alexander Yu, Ariadni Levering
Faculty Mentor: Victor S. Sheng

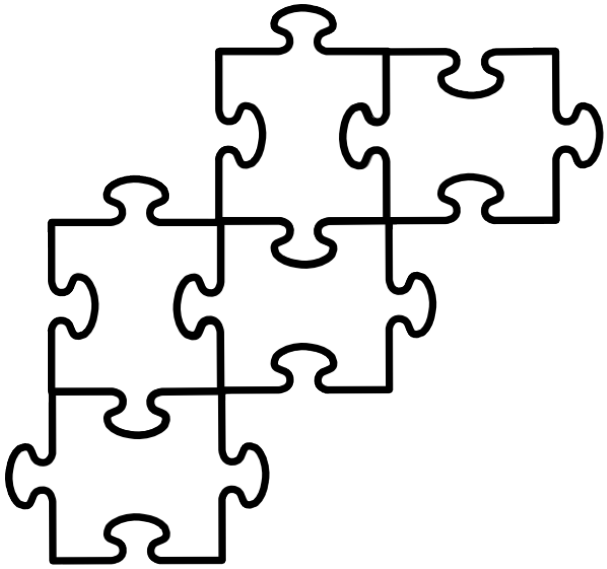
Traditional Complex Event Processing systems (CEP) did not consider the computation requirements of continuous dynamics of IoT (Internet of Things) resources. In addition, event composition rules were predefined before a CEP engine began working. These rules defining tasks are error-prone and cumbersome. In this paper, a hybrid complex event service is proposed, which deals with not only discrete events but also continuous behaviors based on IoT resource models. In order to satisfy the real-time constraints of processing IoT events, a divide-and-conquer principle is adopted, where we give a combination theorem such that different events can be processed on different IoT resources and then processed results can be combined to derive complex events. Based on modular IoT resource descriptions and event knowledge, we define interest goals to direct event composition without enumerating event relation to define event composition rules. We finally present event composition algorithms and evaluation to show our idea.

Autonomous Drone Video Capture

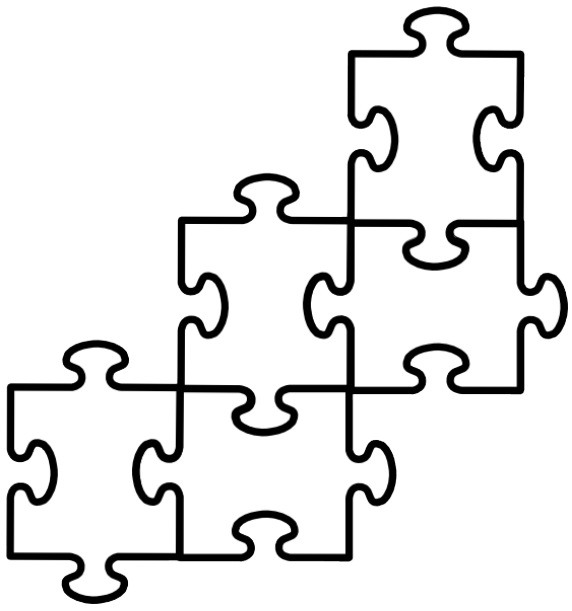
Alexander Yu, Yaying Li, Abhilash Muthyala, Sravani Marreddy,
Thomas Coolidge, Alexandr Dementyev
Faculty Mentor: Yu Sun

According to IT Agenda, drones are known as unmanned aerial vehicles (UAV) flying robots. UAV are mostly associated with military activity, but they are also used in search and rescue (SAR), traffic monitoring, weather monitoring, and other innovative and unconventional applications. For example, Amazon is developing plans to deliver goods to customers near supply warehouses via airborne drone delivery. This is leading drones to become a part of everyday life. There is constant research and development to find ways to use drones to assist in tasks that are inconvenient or difficult for humans to do.

One task that drones are uniquely suited for doing and that is crucial is continuous monitoring of people and/or objects. In our study we will present an autonomous video capturing assistant drone. We intend to develop an autonomous control system which will allow a drone to lock onto and follow a target. Once the drone has locked on to the target it will continue to follow and attempt to keep it in focus. We will create an interface that will allow us to dynamically assign the target as well as the parameters such as distance to the target and height of the drone. Ultimately this project will allow for the capture of video from perspectives that are impossible for humans and should have many applications in monitoring and surveillance.



Department of Geography



Efficient Use of Space: Mixed-Use Planning through the Eyes of Conway's Top Restaurants

Will Dane
Faculty Mentor: Jeff Allender

Chick-Fil-A and Cracker Barrel are top two ranked restaurants in Conway based on profit. It would come as no surprise that these two are both located in highly segregated commercial sectors of town. It may be surprising, however, to find that the smaller restaurants often found in mixed use environments regularly outperform both restaurants after accounting for their size. Since acreage is considered one of the most valuable commodities of a developing city, it is not unreasonable to measure not in standard commercial profit, but in the tax awarded to the city per acre.

Spatial data can be analyzed using parcel data courtesy of the County Assessor Mapping Program and tax rates and profit statistics are available courtesy of The Pulse of Conway online newsletter. Acreage of each site is then calculated using GIS techniques in ArcMap 10.2.2. Finally, the raw data is organized in a spreadsheet and analyzed for both property and sales tax revenue awarded back to the city.

The analysis confirmed that all four of the smaller, more efficient restaurants located in mixed, dense parts of town proved themselves more valuable to the city based on a per acre measurement scale. Mike's Place proved exceptionally efficient, earning an astounding 25 times more than Cracker Barrel for its acreage. Clearly total profit is not the only factor at play here. From the perspective of the local government, a small business in a mixed use environment is far more valuable, producing revenue for the city in both property tax and sales tax while keeping wasted space to a minimum. It is imperative that acreage be given more credit, as it is truly the most influential commodity in determining city revenue. Moving into the future, cities will have to acknowledge the lost income caused by segregated low density planning.

Predicting the Next Move of the Florida Panther

Margo Jordan
Faculty Mentor: Mary Sue Passe-Smith

The Florida panther's (Puma concolor) ancient range was all across North America and even into parts of South America; so extensive, in fact, that there were several subspecies as well. Now, however, the panthers are down to one species, the Puma concolor coryi, and that one is quickly depleting. Poaching, disease, a small genetic pool and car accidents have depleted the population even more in recent years and its making it hard for the panther populations to bounce back. Thanks to dedicated organizations like the National Wildlife Federation and the Big Cat Rescue, the populations are starting to make small comebacks. If these comebacks continue to be successful, then it is likely that the panthers will leave the wildlife areas where they are currently located and expand to new territories. According to Defenders.org, some male panthers have already begun to move to central and northeast Florida, central Georgia, and near the Alabama border. If ideal panther habitat is defined using raster GIS methods, utilizing distances from roads and major cities; selecting correct mean temperatures; identifying and extracting their preferred land cover, then we should be able to predict where the Florida Panther will most likely move next, and plan for protecting and preserving larger areas to shelter this magnificent animal.

Predictive Habitat Mapping of Asimina triloba (Common Pawpaw) in Pennsylvania, USA

Nate Weston
Faculty Mentor: Mary Sue Passe-Smith

Asimina triloba, or the common pawpaw, is a member of the Anonnaceae family of plants. A. triloba fruit is large, the largest edible fruit indigenous to North America and was highly prized by Native Americans. A. triloba fruit is ecologically valuable in forest landscapes, as many animals depend on its bounty. Many conservationists desire propagating A. triloba for ecological restorations, education, landscaping, or as a native food source. However, A. triloba's life history causes it to occur in only select sites, which this project seeks to map across a suit of environmental factors in Pennsylvania, a considerably-diverse region. Selection criteria consisted of: deciduous or mixed forests, moderate or well-drained alfisols, inceptisols or ultisols, and north-aspect topography. The objective was to accurately predict habitat in a location reporting broad distributions, to assist conservation efforts in discovering healthy A. triloba stands. We predict mesic sites within hardwood forests to express the greatest habitat suitability for A. triloba.

City Redlining: Little Rock and The Bronx

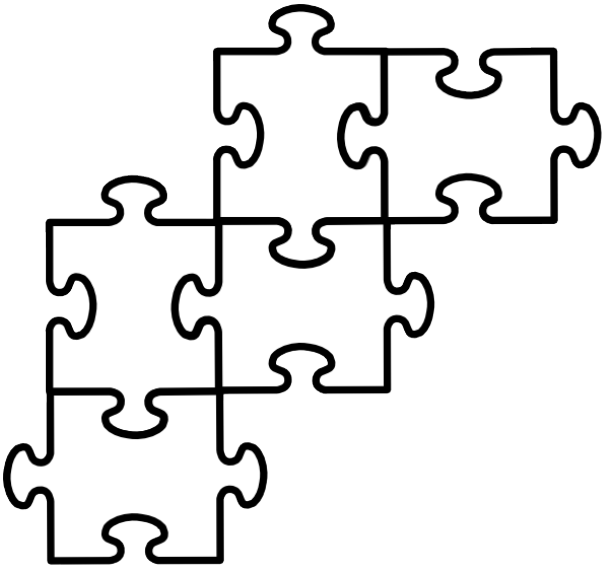
Isaac Sims
Faculty Mentor: Jeff Allender

This essay is a comparison of redlining in the downtown Little Rock area in the 1950's to the 1970's and the Bronx in the 1960's and 1970's. Redlining is defined as withholding amenities, goods or services from a minority ethnic group. It is fueled by prejudice and in most cases the practice is directly tied to where these minorities live. As a small southern city, Little Rock experienced singular effects of redlining from its centralized city planning commission and a biased base of white leaders. The results were an unjust redevelopment of an excellent and envied area of downtown Little Rock which, not coincidentally, happened to be the heart of the negro community. In New York City, low-income and racially segregated areas of the Bronx were subject to a militant mindset from New York City's Research and Development Corporation (RAND). This resulted in a removal of certain services from poor neighborhoods. The primary motivation for this study is to examine the unique characteristics of the two cities, how city planning efforts in both locations factored into redlining, and the primary results and conclusions that can be drawn from each case. The poster will include spatial representations showing in detail the areas that were selected for redlining for Little Rock and the Bronx.

The Colorado River: Uses of the River, Conflicts, Compacts, and a New Solution for the 21st Century

Aubree Page
Faculty Mentor: Michael Yoder

The Colorado River Basin is located in seven states of the American West, and the Republic of Mexico. Formed by small streams created by snow melt in the Rocky Mountains, the 1,450-mile-long river is essential to daily life of the areas that surround it. The river's most common uses include municipal water supplies, hydroelectric power, irrigation for agriculture, and recreation. The Colorado River Basin has been altered dramatically since laws were implemented in 1922 and 1944 to manage it. The regulations that applied then are not relevant to the basin's present-day environmental circumstances. This research discusses the disputes between basin states of the U.S. and the Republic of Mexico over the Colorado River and the ways that the water rights have or have not changed since then. Further, it addresses the ways that the water is distributed throughout the U.S. states around it and the ways the river water is (mis)used in the basin states. Also included is a discussion of the major problems over the past ten years due to drought, a growing population in the West, and unpredicted climate change that has rendered the old agreements outdated.



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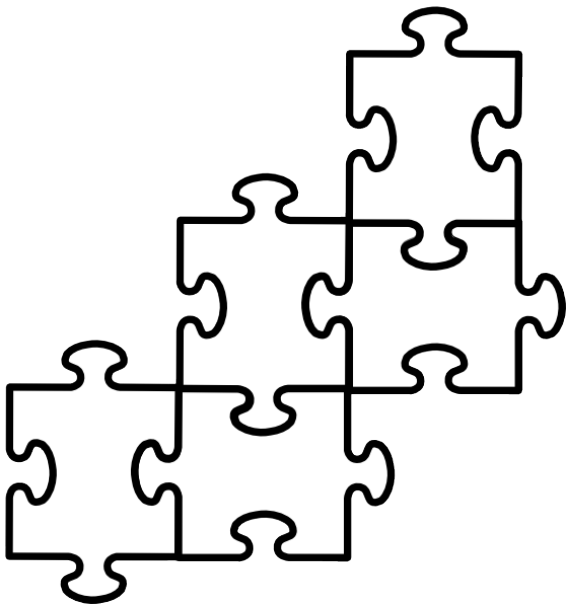


Nonclassical Symmetries of a Nonlinear Diffusion/Wave Equation and System Equivalents

Brandon Ashley, Seth Bloomberg and Thomas Deatherage
Faculty Mentor: Danny Arrigo

It is generally known that classical point and potential Lie symmetries of differential equations (the latter calculated as point symmetries of an equivalent system) can be different. We question whether this is true when the symmetries are extended to nonclassical symmetries. In this poster we consider two classes of nonlinear partial differential equations, the first a diffusion equation, the second a wave equation. We will show that in the general case, the nonclassical point symmetries are inclusive to the nonclassical potential symmetries. We also highlight special cases when the opposite is true.

Asymptotic Tracking and Disturbance Rejection of the Blood Glucose Regulation System

Brandon P. Ashley
Faculty Mentor: Weijiu Liu

For people with type 1 diabetes, the pancreas does not correctly secrete the amount of insulin to keep the concentration of glucose in the bloodstream within the desired range. To correct this, external insulin pumps have been designed to control the blood glucose system. Mathematically, we can represent these systems as a control model with multiple feedback controllers. For the blood glucose system in particular, it is desirable for controllers to stabilize the system about some reference point while correcting for various disturbances in the glucose levels. Here we wish to design controllers for a blood glucose system about some reference and subject to functional disturbances using asymptotic tracking and disturbance rejection methods.

The Relationship Between Teacher and Student Attitudes Toward Mathematics and Reform Oriented Teaching

Haley Laffoon
Faculty Mentor: Linda Griffith

Over a single semester, seventeen instructors and their students participated in a study that compared attitude toward mathematics, the teachers' degree of reform, and the students' grade in the course. Ten of these classrooms took place in the mathematics department at a medium-sized Midwest public university and the other seven took place in the surrounding school districts. Each class was observed by the principal researcher, and attitude surveys were administered. The Reformed Teaching Observation Protocol (RTOP) was used by the principal researcher to determine the teachers' degree of reform. The Attitudes Toward Mathematics Inventory (ATMI), developed by Martha Tapia and George E. Marsh was used to measure student attitude toward mathematics. A survey developed by Kathryn E.H. Race was used to measure teacher attitude toward teaching mathematics. Grades were reported for all participating classes at the end of the fall semester.

Results were analyzed to determine whether there were any relationships between the four factors: degree of reform, student attitude, teacher attitude, and grade in the course. It was found that there were significant relationships among student attitude, gender, level (secondary vs. university), and performance. In this study, females outperformed males, secondary students outperformed university students, and student attitude was positively correlated with performance. However, the effect of teacher attitude or degree of reform on student performance was inconclusive.

Measuring the Effectiveness of Federal Funding using Social Network Analysis

Rebecca Moody
Faculty Mentor: R.B. Lenin

We use the publications dataset of researchers of Arkansas, who are supported by a federal grant for a period of four and then five years, to measure the impact, both qualitatively using dynamic social networks, and quantitatively using statistical measures such as degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality. Through this analysis, we propose to identify key researchers who strengthened the collaborative network in terms of their contributions, importance, and participation.

HypoTest: Interactive Hypothesis Test Package for R

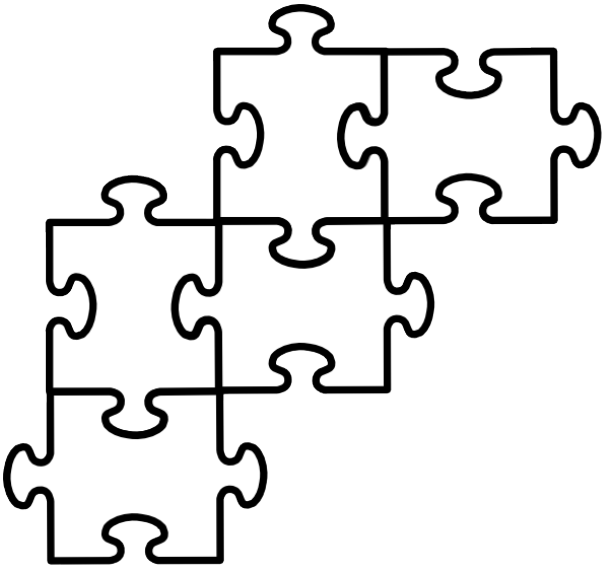
James Palmer
Faculty Mentor: R.B. Lenin

We developed a package in the R programming language known as HypoTest which contains user-friendly functions to perform various hypothesis tests as part of inferential statistics. Both a graphical user interface and command line interface, as well as supporting documentation and a color coded chart of the available functions is included in the package.

Epidemic Model with Diffusion

Alma Malibekova, Diana Morales
Faculty Mentor: Long Le

Our research focuses on mathematical modeling of an epidemic within a population. It consists of a system of four non-linear ordinary differential equations that represent the groups of potential, exposed, infected and removed populations. The steady states for the system are found and their stability is analyzed using Routh-Hurwitz criterion. The goal of the research is to find and study the endemic stability state.



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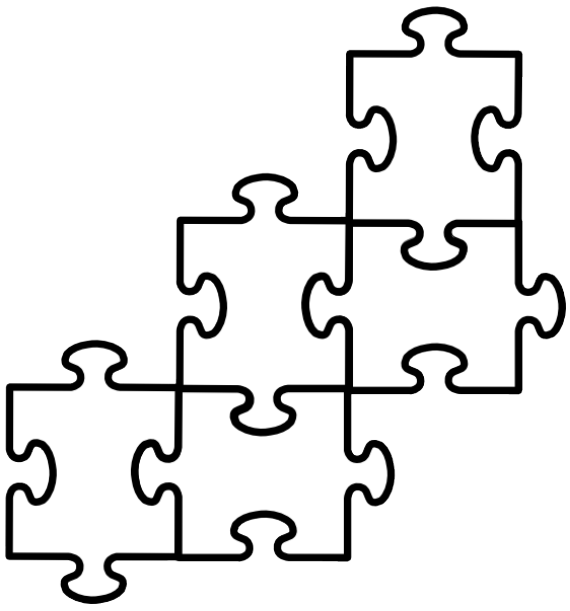

Gamma-Gamma Coincidence

Jordan Barajas, Christina Junkans, Max Milan
Faculty Mentors: Rahul Mehta, Azida Walker

An experiment was done to examine the effect of angular dependence on detection of coincidence gamma rays emitted by positronium formed in the decay of ^{22}Na. ^{22}Na undergoes β+ decay and interacts with electrons in the surrounding material resulting in the formation of positronium with momentum essentially equal to zero. The positronium then rapidly annihilate into two gamma rays which travel away from each other in opposite directions to conserve momentum. Using two NaI detectors to collect the photons, a voltage pulse was generated and mapped on a multi-channel analyzer as a Gaussian distribution. One detector was connected to a shaping amplifier and the other to a delay amplifier to allow for only the measurement of pulses that reflected coincidences. The arm of one detector was rotated from 0 to 13 degrees in the clockwise and counterclockwise directions at two different distances from the source in order to understand the angular dependence of detection. From 0-5 degrees there was a sharp decrease in the region of interest and from 7-13 degrees the region of interest decreased very little as it approached a limit of the background count. For the distance of 33.2 cm, the angle was increased to 7 degrees before the region of interest dropped to approximately half of its maximum value while for the 19.7 cm distance the angular separation reached 10 degrees before the region of interest dropped to approximately half of its maximum value. This is difference in the rate of decreasing intensity is reflective of the reduced cross sectional area of the overlap between the surfaces of each detector. The results of this experiment confirm that the intensity of the source is strongest when the angular separation of the detectors is 0 degrees.

Potential Differences in Problem Solving Approaches When Using Different Textbooks

Charles Bertram
Faculty Mentor: Andrew Mason

In the Spring 2015 semester the algebra-based introductory College Physics course sequence switched to “College Physics” by Etkina, Gentile, and Van Heuvelen. This textbook takes a specific focus in developing problem solving skills and inspiring higher-level reasoning with active engagement and real-world applications. With this project we hope to show that there is a difference in problem solving strategies used by students when the course uses “College Physics” as opposed to using the textbook used prior to Spring 2015, “Physics: 9th Edition,” by Cutnell and Johnson. Audio-visual data and written artifacts have been collected that demonstrate group-based problem solving during a pre-lab, context rich problem solving session. This data is being analyzed for trends in the frequency of problem solving strategies that were used to solve a similar problem during the Spring 2014 (with “Physics: 9th Edition”) and Spring 2015 (with “College Physics”) semesters. If the frequencies of epistemic games across the two semesters are determined to be significantly different from each other, a difference in trends in problem solving when using different textbooks.

Using the H-β Emission Line as a Means of Mass Determination for Spiral Galaxy AGNs

Jacob Cameron and Lucus Ratz
Faculty Mentor: Debra L. Burris

This study focuses on the AGN of spiral galaxies in hopes to use the H-β line to determine the mass of the central black hole. We are replicating the method of Vestergaard and Peterson by extinction correcting emission spectra from these black holes, both for cosmic redshift and for FeII emissions using IRAF. From there we can accurately measure the full width half max of the H-beta line in these spectrum as well as the lumosity and these paired with the OIII lines give us an estimate on the mass of the black hole. The purpose of this is to compare it to the values to pitch angle measurements and to explore the Mass-Pitch Angle relation as outlined by J. Kennefick from the University of Arkansas.

La and Eu Abundances in Metal-poor Halo Stars

Harrison Cardillo
Faculty Mentor: Debra Burris

Elements with atomic number greater than Z=26 (the Iron Peak) cannot be formed through fusion in a star's core; the majority of these elements are produced through one of two neutron-capture processes. Early in the history of the Galaxy, the rapid neutron-capture process (r-process) is believed to be responsible for the production of elements Z=56 and beyond. These elements require at least one generation of stars to have completed their life cycle in order to be synthesized. Therefore, if we observe the heavy metal abundances in what are called Population II stars (metal-poor stars), then we can begin to make inferences about the chemistry of the earliest stars in the Galaxy. To contribute to this picture of the early universe, the Lanthanum and Europium abundances of low-metallicity stars will be measured and trends in these abundances based on comparisons to existing related literature will be sought.

Focus of Biology and Health Science Majors in Introductory Physics Problem-solving: Concepts vs. Equations

Carmen Chenault
Faculty Mentor: Andrew Mason

Lab group dynamics may influence the efficacy of group-based problem solving pedagogy, including attempts to learn metacognitively. Currently I am analyzing written group problem solving artifacts from previous semesters' student rubrics and scenario work pages. Each student's responses were categorized by how thorough they were explaining struggles they had and mistakes they made. Categories were about whether they understood the rubric, whether they could solve the problem independently on their own understanding, and whether students were focused more on equations or on concepts on the written artifacts. The overall goal of the study is to investigate the respective preferred approaches of biology majors and health science majors in their group-based problem-solving attempts. With regard to individual student lab groups, I am also currently establishing a definition of which member of a given lab group (if any) exhibits a leadership role. Future work involves comparing these group leadership roles to choice of major declared by students.

Scanning System for Measuring Acoustic Wavefields

Clinton Costello
Faculty Mentor: Carl Frederickson

Reflecting a spherical wavefront from a surface with a specific shape will produce a transverse cusp caustic. This caustic encloses a region where three rays focus from the reflected wavefield. A system has been developed to allow a microphone to be scanned through the acoustic caustic in space. National Instruments LabView software is used to control the movement of the microphone and the collection of data. This system will be used to characterize the source as well as the reflected wave. Preliminary data will be presented.

Developing the Measurement Software for Impedance Tube and Testing of Porous Media Under Low Frequencies

Angelo Gomes
Faculty Mentor: Carl Frederickson

New software is being developed to control data collection in an acoustic impedance tube. This system can be used to measure acoustic properties of porous materials. The new software controls both the source signal and the data collection allowing for better quality control of the recorded data. Previously a system was used that did not allow for the inspection of the individual data points. This is necessary to ensure that data is not being collected beyond the useful range of individual electronic components. This new system will allow for deeper inspection of each individual data file when anomalies occur.

Derivation of the Kinematical Scattering Factor, and Testing it as a Function of Sample Atomic Number, Energy of the Ion Beam and the Scattering Angle

Angelo Gomes, Kenneth Jumper
Faculty Mentors: Rahul Mehta, Azida Walker

In this experiment, the Kinematical Scattering factor will be derived using energy and momentum. The bombarding of high energy Hydrogen ion beams produced by a Tandem accelerator off of a Gold-Silicon foil was measured. With the beam fixed at 1.4 MeV, deflections were observed at varying angles with respect to the Gold-Silicon sample. At first, the detector was placed at 180 degrees to the target, and was changed after each successive observation. With the data collected, the kinematical scattering K were calculated. Then, the experimental results were compared to the accepted values at those angles. The experiment was in agreement with the theoretical equations for the Kinematical Scattering factor $K_m(\theta)$. Lastly the angle was held constant and the energy of the ion beam was varied. Scattering of the ions at a fixed angle is used to experimentally check the K factor of the Gold and the-Silicon nucleus.

X-Ray Fluorescence and Moseley's Law

Brandon Miller, Jacob Cameron, Clint Costello
Faculty Mentors: Rahul Mehta and Azida Walker

When a nucleus is bombarded with gamma rays of enough energy, they are ionized, and as the electrons "fall down" into lower energy states, they emit x-rays: These are known as fluorescent x-rays. There are several different paths an electron can take when moving to a lower energy state (i.e. moving between different shells), and these emit x-rays with different energy levels; for example, when an electron falls from the L-shell to the K-shell, a Kα x-ray is emitted, and a transition from the M shell to the L shell emits an Lα x-ray. A rhodium beam was used to cause several different elements to fluoresce K-shell and L-shell x-rays. The x-ray spectra were collected, and the energies (in keV) were measured in the program DppMCA connected to the Amptek x-ray detector that was calibrated from an americium-241 source that alpha decayed to neptunium-237, which then emitted Lα and Lβ x-rays of known energies of 13.9 keV and 17.7 keV respectively. The detector used only detected up to 20 keV x-rays, meaning only K- and L-shell x-rays could be detected. There is a relationship between the number of protons a nucleus has (its atomic number) and the energy of the emitted x-rays, and this relationship is called Moseley's law, which states that the frequency (and, from Planck's law, the energy) is directly proportional to the square of the number of protons in the nucleus. It has great historical significance, as it provided strong evidence for the experimental existence of atomic numbers, and led to the current ordering of the Periodic Table of Elements. A plot of energy vs. the atomic number squared yields a straight line, which was used to obtain a relationship similar to Moseley's Law. This relationship was then used to identify elements present in various unknown samples.

Designing and Building a Fluid-Powered Bicycle

Seth Thomas, Harrison Cardillo, Caleb Webb, Max Milan
Faculty Mentor: William Slaton

Our team enrolled in the 2015-2016 Parker-Hannifin Chainless Challenge to design a human-powered vehicle that manages power transmission using fluid power instead of a traditional chain and sprocket mechanism. Although the chain remains a much simpler and more efficient means of power transmission for bicycles and similar vehicles, this national design challenge was primarily created to expose students to the fluid power industry and the engineering process, giving would-be engineers experience in their chosen field. The competition allowed us to build, test, and apply an experimental fluid power technology, a pneumatic strain-energy accumulator, which serves as an energy storage device in fluid power applications.

To complete the challenge, our team: designed a fluid-powered circuit, developed a CAD model of our bicycle, selected components and hardware from multiple suppliers, designed and fabricated many customized parts using a machine shop, created an electronic circuit for managing components using a programmable Raspberry Pi micro-controller, and assembled and tested a working prototype. We were also required to exercise a set of non-technical skills: namely, securing funds to build the bike, maintaining contact with the sponsors, regularly presenting updates of our work, managing a budget and timeline, and working together as a team.

Though we were unable to display our bicycle in California for the final race, we did successfully build and test a prototype that included a hydraulic transmission interface and a pneumatic energy storage system for regenerative braking. The hydraulic transmission was accomplished using a pair of linked, synchronized hydraulic cylinders while the pneumatic energy storage system utilized a pneumatic cylinder, valves, and a bank of experimental strain-energy accumulators.

Modeling Lightning Formations in a Numerical Thunderstorm Model

Kayla Waters
Faculty Mentor: Debra L. Burris

Understanding the formation of lightning is useful for a complete picture of how the electrical charging of a thunderstorm evolves with time. A simple model of dielectric breakdown can be used to simulate lightning formation in a computer model of a thunderstorm. Varying parameters in the model will obviously effect the formation and frequency of lightning strikes in this model. By seeing how these variations effect the model a better understanding of the evolution of the storm is obtained. This leads to more effective measures of protecting lives and also preventing damage to property

Circuit Analogies in Loudspeaker Design

Micheal Wilson
Faculty Mentors: Carl Frederickson, William Slaton

An RE SX 18” subwoofer mounted in a 4^{th}-order bandpass enclosure is considered as a lumped acoustic impedance model to find the pressure inside the vented chamber. Resistors act as dissipation and loss of acoustic pressure through radiation resistance, viscous, and thermal effects of the propagation of the sound wave through the element. Air chambers were modelled as capacitors, and the un-flanged, rectangular duct (port) was modeled as an inductor. The equivalent circuit is then analyzed with Kirchoff’s Laws to find the current (particle velocity) in the front chamber, and the subsequent voltage (acoustic pressure) as a function of frequency. The subwoofer is also modelled as an equivalent circuit. Then, by utilizing a TermLAB SPL microphone placed inside the front chamber, and applying a constant drive amplitude to the subwoofer, the measured SPL is obtained and compared to the theoretical result to establish the model validity.

Alpha Particle Energy Loss through Matter

Micheal Wilson, Sarah Spellmann, Caleb Webb
Faculty Mentors: Rahul Mehta, Azida Walker

An Americium-241 source emits a detectable distribution of α-particles that undergo a change in energy in terms of the peak and variance (width of the distribution) when the particles travel through material. This is due to the collisions of the α-particles with the electrons in the matter, and the Coulombic interaction. The average rate of energy loss as they traverse the copper is related to the thickness of the material by the linear attenuation coefficient. As such, the source is placed in front of copper films of varying thicknesses for five minutes and α-particle interactions with a silicon wafer (a PIPS detector) are measured. Copper films of varying thicknesses produce distinctly different distributions of α-particles. The thicknesses were 0, 1.76, 2.51, 3.41, 4.15, 4.85, 9.73 μm. As thickness increased, the variance of the α-particle energy distribution increased. Furthermore, the measured distributions show a decrease in the mean energy and total counts. Concluding that the change in energy loss for each test was proportional to the thickness.

Effect of Hind-Limb Suspension and X-Ray Irradiation on Elasticity of Rat Bones

Hayley N. Heacox and Lawrence M. Benzmiller
Faculty Mentors: Rahul Mehta, Azida Walker, and Brent Hill

This research aims to study changes in elasticity of rat bones when exposed to space-like conditions of simulated microgravity and cosmic radiation. Microgravity is induced in the rats through hind-limb suspension (HLS). The animals are maintained for two weeks before they are sacrificed. For this specific data set, the animals were radiated via x-ray radiation (IR) in 3-day intervals with a dose of 0.5 GY over the two-week time period of suspension. The non-radiated and/or the unsuspended animals provide the control data. A technique known as three-point bending is employed. A known amount of force is exerted upward perpendicular to the middle of each bone, which is held fixed at each distance by a specially developed holder. A motorized force transducer performs the upward force. The force applied at each distance is recorded in real time. A modified Euler-Bernoulli beam theory equation is applied to estimate the Young's (elastic) modulus for the leg bones. A LASER-based bending setup (Cantilever) may be utilized as a second methodology to provide complementary results. In this setup, the leg bones are fastened by a vice at one end, and a force is applied horizontally via a pulley system. Through the use of similar triangles, the data is then used to determine the strain and further analysis provides the elastic modulus. The bones are then cross-sectioned to find the moment of inertia for the calculation of the modified Euler-Bernoulli Beam Theory. Analysis of results clearly point to a less elastic nature of leg bones exposed to HLS or IR compared to leg bones that were not suspended or irradiated. Overall, a lessening of the elastic modulus indicated a weakening of the bones under space-like conditions of microgravity or cosmic radiation. It is hypothesized that the treatments applied conjointly should result in a more thorough weakening.

Student Author Index

UCA Faculty Mentor Index