2020 RESEARCH & CREATIVE INQUIRY DAY

Tennessee TECH

15th Annual Event | April 2020

tntech.edu/research/research-day

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Tennessee TECH

U.S. House of Representatives Resolution

H. Res. 1654

In the House of Representatives, U. S.,
November 16, 2010.

Whereas close to 600 colleges and universities in the United States and thousands of undergraduate students and faculty pursue undergraduate research every year, providing research opportunities that will shape the trajectory of students' lives and careers and researchers' and institutions' purpose and contributions to academia and the research enterprise;

Whereas students and faculty engaged in undergraduate research contribute to research across many disciplines, including arts and humanities, biology, chemistry, health sciences, geosciences, mathematics, computer science, physics and astronomy, psychology, and social sciences;

Whereas research at the undergraduate level provides both students and faculty members opportunities for improving and assessing the research environment at their institution, develops critical thinking, creativity, problem solving, and intellectual independence, and promotes an innovation-oriented culture;

Whereas undergraduate research is essential to pushing the Nation's innovation agenda forward by increasing the interest and persistence among young people in the crucial science, technology, engineering, and mathematics (STEM) disciplines, and to cultivating the interest of would-be researchers who pursue a new aspiration of graduate education after participating in undergraduate research; and

Whereas the week of April 11, 2011, would be an appropriate week to designate as "Undergraduate Research Week":

Now, therefore, be it

Resolved, That the House of Representatives—

(1) supports the designation of "Undergraduate Research Week";

(2) recognizes the importance of undergraduate research and of providing research opportunities for the Nation's talented youth to cultivate innovative, creative, and enterprising young researchers, in collaboration with dedicated faculty;

(3) encourages institutions of higher education, Federal agencies, businesses, philanthropic entities, and others to support undergraduate research and undergraduate researchers and their faculty mentors;

(4) encourages opportunities, including through existing programs, for females and underrepresented minorities to participate in undergraduate research; and

(5) supports the role undergraduate research can and does play in crucial research that serves the Nation's best economic and security interests.

Attest:
Clerk.

STATE OF TENNESSEE

PROCLAMATION

BY THE GOVERNOR

WHEREAS, graduate education attracts over 27,000 students nationally and internationally to Tennessee universities, awards over 8,500 graduate student degrees from Tennessee public and private institutions annually, and contributes to the economic growth and stability of the State, generating more than 1.1 billion dollars in economic impact; and

WHEREAS, graduate education in Tennessee is enhanced by assistantships and involvement with local organizations and businesses that participate in the advancement of resources to the community and to the public; and

WHEREAS, Tennessee graduate students and graduate education across the state have helped increase the earning power of Tennessee citizens, have attracted new businesses and creative ideas such as artificial intelligence, neuroscience, the arts, biomedical engineering, nanotechnology, information technology, literacy, materials science, and children's health; and

WHEREAS, Tennessee graduate faculty engage in internationally-recognized scholarship, producing a significant body of research that contributes to the broad base of knowledge essential for advancing education in the State; and

WHEREAS, alumni from Tennessee graduate schools occupy leadership roles in school systems, institutions of higher learning, health-related institutions, businesses, government, and politics; and

WHEREAS, Tennessee universities have recognized the strengths and contributions of a culturally diverse student body and as a result attract student scholars from diverse backgrounds interested in pursuing graduate education;

NOW, THEREFORE, I, Bill Lee, Governor of the State of Tennessee, do hereby proclaim the week of February 10 through February 16, 2019, as

Graduate Education Week

in Tennessee and encourage all citizens to join me in this worthy observance.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the official seal of the State of Tennessee to be affixed at Nashville on this twenty-second day of January, 2019.

Bill Lee

Governor

Tre Hargett

Secretary of State

Due to the conditions surrounding the COVID-19 epidemic this year, the current Governor's Proclamation was unavailable. It will be updated in the online digital file as soon as a copy can be obtained.

Foreword

The Office of Research and Economic Development welcomes you to the 15th Annual Research and Creative Inquiry Day. This event provides an opportunity to showcase student research and creative inquiry projects from departments across Tennessee Tech's campus. Student research experiences are important as they stimulate active learning and teamwork, cultivate mentoring relationships, improve critical-thinking skills, and provide students with the knowledge and expertise to evaluate situations creatively.

Since a large group gathering was not possible due to the developments regarding the Novel Coronavirus (COVID-19), the 2020 Research and Creative Inquiry event moved to a digital format. The primary goals of the reimagined event are to provide students with the experience of preparing an abstract and poster/paper, while ensuring there is no additional burden placed on them in light of all of the new circumstances they are navigating.

In recognition of the contributions made by research and creative inquiry to the advancement of knowledge, the U.S. House of Representatives passed a resolution designating a week in April as "Undergraduate Research Week," and Governor Lee of the State of Tennessee proclaimed February 9 through 15 as "Graduate Education Week."

This year's event features posters and papers generated from 211 submitted abstracts on topics as varied as the 22 fields of study from which they originate.

Congratulations to the students and faculty advisors who have worked hard to prepare these posters and papers that demonstrate Tech's dedication to excellence in learning and discovery. Thank you to the judges who volunteer their time to evaluate the students' work. This event would not have been possible without the support of the entire campus community.

Special Appreciation & Acknowledgments

Tennessee Tech Offices, Departments and Staff

Information Technology Services, Library Services, Office of Communications and Marketing, Office of Creative Inquiry/QEP, Printing Services, Student Services

We would like to extend a special thanks to Kristen Deiter, associate professor of English, for coordinating the paper portion of the event and to Holly Mills assistant professor in the Volpe Library, for coordinating the online research poster-design workshops.

We also wish to acknowledge David and Sherri Nichols for their endowment to support student research and creative inquiry.

A highlight this year is is the inclusion of three creative media inquiry projects developed by students in the SOC 1650 Social Problems course

In conjunction with this year's event, you are invited to view three creative media inquiry projects that are available on the event web page at tntech.edu/research/research-day/index.php. These videos were developed in the Social Problems (SOC 1650) class taught by Ada Haynes, professor of Sociology, during the Fall 2019 semester. During this course, students explored a social problem through research with a creative inquiry and sociological lens. As part of the QEP sponsored redesign of the course assisted by Jacob Kelley and Instructor Andrea Arce-Trigatti, students developed creative projects displaying an effective media campaign that promoted awareness and/or offered an innovative solution to the social problem studied. Three videos were selected for inclusion in this event. Abstracts for the three video projects can be seen on page 55.

Schedule of Events

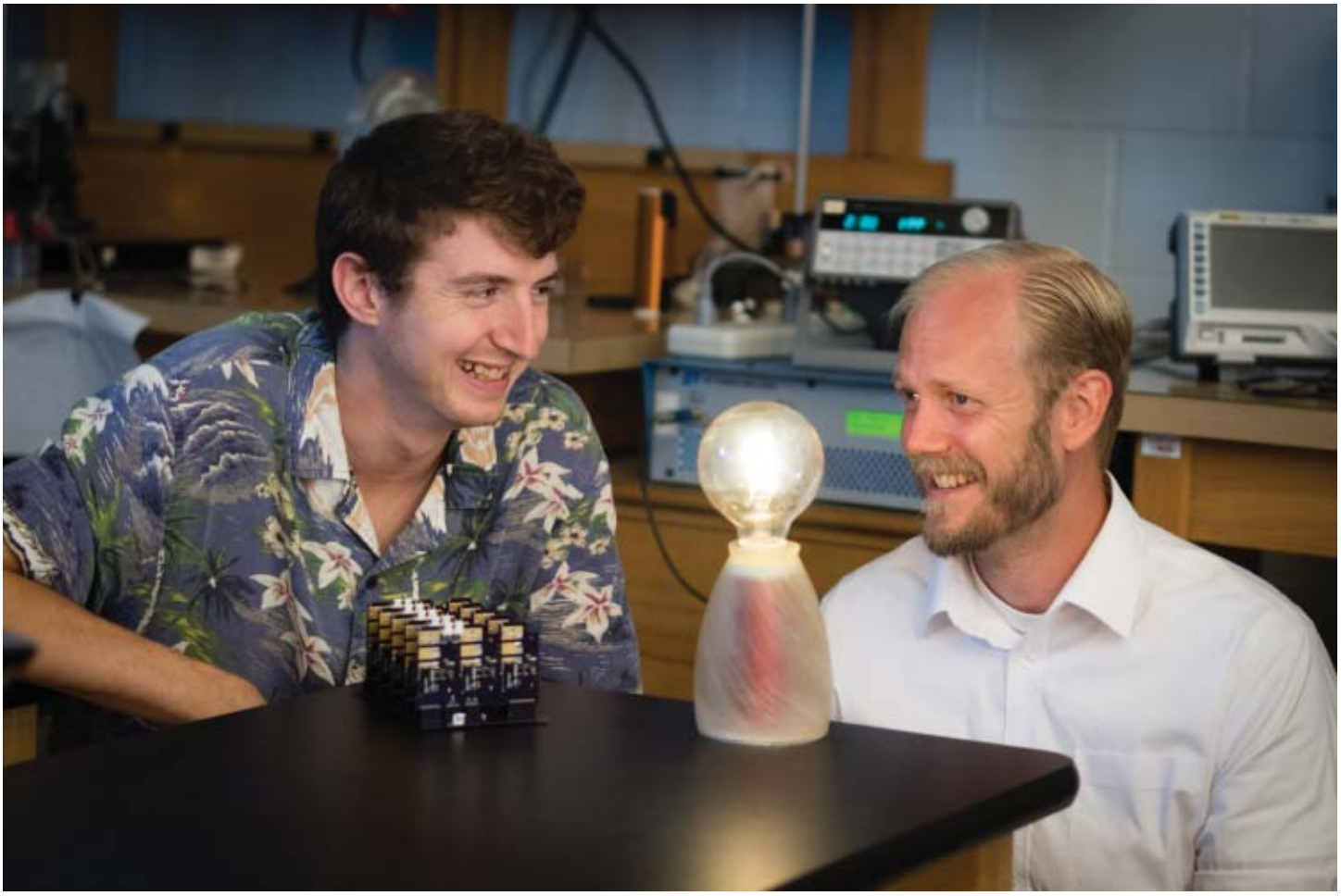
The 15th Annual Research and Creative Inquiry Day

Due to the developments regarding the Novel Coronavirus (COVID-19), the 2020 Research and Creative Inquiry event was held in a digital format. The following is the event timeline revised to accommodate that platform:

Monday, April 20: Deadline for participants to submit a PDF file of their poster/paper

April 21-24: Judges evaluated posters/papers based on evaluation forms posted on the event website

Week of April 27: Winners announced and certificates mailed



2020 Judges

Holly Anthony – Curriculum and Instruction
Steve Anton – Mechanical Engineering
Curtis Armstrong – Decision Sciences and Management
Megan Atkinson – Volpe Library
Debbie Barnard – Foreign Languages
Joseph Biernacki – Chemical Engineering
Jeremy Blair – Art, Craft, and Design
Chris Brown – Biology
Andrew Callender – Chemistry
Derek Cashman – Chemistry
George Chitiyo – Curriculum and Instruction
Scott Christen – Communication
O. Andreea Cojocaru – Chemistry
Janet Coonce – Chemistry
Tania Datta – Civil and Environmental Engineering
Kristen Deiter – English
William Eberle – Computer Science
Robert Engelhardt – Physics
Ismail Fidan – Manufacturing and Engineering Technology
Maanak Gupta – Computer Science
Ann Hellman – Nursing
Nicole Henniger – Counseling and Psychology
Adam Holley – Physics
Samantha Hutson – Human Ecology
Stephanie Jorgensen – Chemical Engineering
Stephanie Kazanas – Counseling and Psychology
Mary Kidd – Physics
Duck Bong Kim – Manufacturing and Engineering Technology
Ethan Languri – Mechanical Engineering
Ed Lisic – Chemistry
Leora Loftis – Pace Analytical
Colleen Mestayer – Communication
Holly Mills – Volpe Library
Gene Mullins – Chemistry
Justin Murdock – Biology
Nikki Panter – Biology
Akond Rahman – Computer Science
Mustafa Rajabali – Physics
Elizabeth Ramsey – Human Ecology
Chad Rezsnyak – Chemistry
Doug Talbert – Computer Science
Sandra Terneus – Counseling and Psychology
Denis Ulybyshev – Computer Science
Hannah Upole – Human Ecology
Daniel VandenBerge – Civil and Environmental Engineering
Lenly Weathers – Civil and Environmental Engineering
Janet Whiteaker – Learning Support Program
Robert Wilbanks – Accounting
Phil Wilbourn – International Business and Cultures
Jeanette Wolak – Earth Sciences
Dale Work – Chemistry
Matthew Younglove – Music
Liqun Zhang – Chemical Engineering

Abstracts

College of Agriculture & Human Ecology

School of Agriculture

Undergraduate

*OVIPOSITIONAL PREFERENCE OF SILVERLEAF WHITEFLY ON BENCHMARK ACYLSUGAR TOMATO BREEDING LINES

Primary Author: Brianah Castleberry, Agriculture

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Erik Koehler; Brain Leckie; Martha Mutschler, School of Integrated Plant Science, Cornell University

Advisor(s): Brian Leckie

The silverleaf whitefly (SLW), Bemisia tabaci B biotype is an invasive hemipteran insect which can cause severe losses in tomatoes. Acylsugar (AS)-mediated insect resistance bred from the wild tomato, Solanum pennelli (SP) has been demonstrated to control a variety insect pests. Using SP LA716, the tomato breeding program at Cornell University produced new AS lines. The program recently transferred the CU071026, the first benchmark line, SP genomic regions controlling AS to a new background (CU17NBL) with superior horticultural traits. The goal of this project is to compare the SLW ovipositional preference between young seedlings of CU17NBL and CU071026, to insure that CU17NBL has at least the same resistance as CU071026. These lines were evaluated at the four true leaf stage in choice tests replicated in small greenhouse cage assays. Cages were infested with ~100 SLW and allowed to oviposit for two weeks. Four replicate assays were performed. Insect counts were recorded weekly at leaf positions one and four. Data was analyzed with a mixed model ANOVA. The week two counts revealed a significant ovipositional preference ($P<0.0001$) for the CU071026 line as it accumulated more than ten times the number of eggs as the CU17NBL. Similar trends were seen for the 1st/2nd instar ($P<0.01$) and 3rd/4th instars ($P=0.004$). The findings of this study indicate that the transfer of the SP introgressions from CU071026 into CU17NBL have reduced the SLW preference compared to CU071026. Further characterization will be needed to understand these results.

Undergraduate

UNIVERSITY FACULTY AND STUDENTS HELPING AGRICULTURE TEACHERS MEET THEIR EDUCATIONAL GOALS

Primary Author: Megan Clark, Agriculture

Co-Author(s)/Collaborators: Dennis Duncan

Advisor(s): Dennis Fennewald

Tennessee currently has 220 high school FFA chapters and over 14,000 FFA members. FFA advisors train their students for career development events (CDE's) and leadership development events (LDE's). FFA advisors typically have a broad education, and sometimes lack the extensive knowledge and experience needed to prepare FFA members for specific CDE's and LDE's. Faculty and students in the School of Agriculture (SOA) at Tennessee

Tech recognized the many challenges advisors face and developed training clinics structured according to state and national FFA CDE and LDE guidelines. University student clubs develop and organize the clinics - specific content and instruction provided by university faculty, volunteers, and experts with extensive FFA experience. The clinics provide FFA members with valuable experience that can prepare them for upcoming FFA events. Since 2012 over 3,600 FFA and 4-H members have attended 45 clinics ranging from horse and livestock judging to floriculture, parliamentary procedure and veterinary science. In order to gauge the impact(s) of the aforementioned clinics, a pilot study conducted and included 15 randomly selected FFA advisors who have participated in past FFA clinics at TN Tech. Results indicate that 86% of advisors strongly agree or somewhat agree that the clinics have supplemented their training, 73% strongly agree or somewhat agree that the clinics have provided training they don't have expertise in, 60% strongly agree that clinics have made their students more competitive, and 92% feel the clinics are well organized.

Undergraduate

*SQUASH BUG OVIPOSITIONAL PREFERENCE WITHIN CUCURBITA PEPO

Primary Author: Grayson Delay, Agriculture

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Erik Koehler; Brian Leckie, Tennessee Technological University

Advisor(s): Brian Leckie

The Squash bug (SB), Anasa tristis, is a devastating insect specialist of squash (Cucurbita pepo) that lays egg clusters on leaves. SB feeding can cause 50% yield losses in conventional and organic systems. SB preference studies in C. pepo have been performed, although with limited cultivars and unreliable results. Cocozelle, pumpkin, vegetable marrow, and zucchini are included in C. pepo subsp. pepo, while C. pepo subsp. texana includes acorn, crookneck, scallop, and straightneck squash. A previous study in the lab revealed a significant SB ovipositional preference for squash in the C. pepo subsp. texana including a preference for cultivars within the scallop and acorn market classes. The objectives of this study were to identify SB ovipositional preference within three C. pepo market class panels at the cultivar level. The within zucchini, acorn, and scallop market class assays were performed in replicated small greenhouse cages with one plant per cultivar and 5 mating pairs released into the cages. Oviposition data was taken at three days and analyzed with a mix model ANOVA using JMP13. While no SB preference within the eight cultivar scallop panel was detected, the eight cultivar acorn panel revealed significant preference for oviposition of several cultivars with Thelma Sanders (P=0.05) being the most preferred. The six cultivar panel of zucchini revealed a significant preference (P=0.05) for several zucchini cultivars with three cultivars (Golden Zucchini, Parthenon, and Caserta) being highly non-preferred. These results may be informative for growers in areas with high levels of SB pressure.

Undergraduate

*DETERMINING OPTIMAL NUTRIENT VALUE THROUGH LEAF TISSUE ANALYSIS ON TOMATO

Primary Author: Sarah Pendergrass, Agriculture

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Michael Best

The number of vegetable producers using controlled environments and hydroponics for production in the

United States has grown significantly in the last decade. There are many different hydroponic nutrient solutions on the market and these solutions have recommended rates of application that are specifically designed to suit the needs of newer hybrid lines. The management of heirloom tomatoes is different as each heirloom line has specific nutritional needs that may require more or less of an individual nutrient than the standard hybrid line. The optimization of Total Dissolved Solids (i.e. fertilizer solution) for each heirloom line is required to achieve the maximum production of saleable fruit. If not optimized, excess fertilization has the potential to become an economic cost and reduce sustainability. Each variety can require a significantly different solution strength in order to reach its maximum potential yield. This work developed methodologies required to determine optimal nutrient plans for three of the tomato varieties being grown at the Tennessee Tech University Oakley Farm greenhouses. Through leaf analysis the tomatoes were tested with an industry standard nutrient package. By testing the leaves, we found that the nutrients were in the normal range for "greenhouse tomatoes", but it was obvious from observation that the heirloom varieties were all lacking individual nutrients like Calcium, Nitrogen and Magnesium. We feel that further research is necessary utilizing individual nutrients instead of a standard nutrient package to determine the appropriate levels of macro and micronutrients needed for the most popular commercial heirloom varieties.

Undergraduate

*ALUMNI PERCEPTIONS OF IMPROVEMENTS NEEDED IN THE TN TECH SCHOOL OF AGRICULTURE

Primary Author: Marisa Phelps, Agriculture

Advisor(s): Dennis Duncan

Any university, regardless of the size of the institution, inherently takes upon itself the responsibility of cultivating the most employable college graduates possible. A university's never-ending quest to stamp its impression upon various industries through their graduates is quintessential to its continuity and the success of its students. Its alumni are undoubtedly a reflection of the quality of the institution. This study was conducted amongst Tennessee Technological University's School of Agriculture alumni in order to magnify what qualities they feel are strengths in the School of Agriculture as well as what strikes them as opportunities for improvement. The perceived value of courses and educational methods in relevance to their current careers were also evaluated. Responses were collected via Qualtrics using quantitative and qualitative research methods. Overall, it was found that the faculty-student relationships within the School of Agriculture were an overwhelming strength. Additionally, alumni identified laboratory experiences in agriculture courses and leadership training in clubs and organizations were beneficial in pursuing current professional endeavors. Meanwhile many graduates felt that support regarding assistance with internship placement was inadequate and their personal marketing skills - resume skills and interviewing abilities, were in need of improvement prior to graduation. Graduates also offered valuable feedback regarding improvements for their particular concentration. The evidence presented has profound implications on the School of Agriculture - how the School may be refined in order to produce students who obtain employment with minimal stress and how it may ameliorate students' experience during their tenure at TN Tech.
Agriculture and Human Ecology

Undergraduate

*PRIOR 4-H AND FFA INVOLVEMENT ON TN TECH SOA ENROLLMENT

Primary Author: Erin Wakefield, Agriculture

Advisor(s): Dennis Duncan

One hundred thirty (42% of total enrollment) randomly selected students in the School of Agriculture (SOA) completed a survey instrument designed to determine which factors impact their decision to attend Tennessee Tech and the SOA. More specifically, this section of the larger study aimed to determine the importance of prior involvement in 4-H and FFA and their decision to enroll in SOA. Students were asked how many years they participated in each of these organizations, and to rank the factors that influenced them to attend based on a Likert scale: 1 (no influence), 2 (little influence), 3 (some influence), 4 (influence), and 5 (high influence). Fifty-four percent of students surveyed were prior FFA members, with 80% responding that their agriculture education teacher had high influence on their decision to attend the SOA, followed by high influence from a friend (62%), family member (51%), and attendance at FFA State Convention (51%). Thirty-two percent of students surveyed were prior 4-H members, with 47% responding that their family had high influence on their decision to attend the SOA, followed by high influence from a 4-H agent (30%), 4-H club leader (19%), and 4-H Alumni (17%). As previously stated, the respondents represent 42% of total enrollment in SOA and the results indicate that both 4-H and FFA involvement played a significant role in their decision to attend Tennessee Tech. Current 4-H and FFA members should be targeted during future recruitment events.

School of Human Ecology

Undergraduate

*NATURE'S BENEFICIAL EFFECTS ON INDIVIDUALS

Primary Author: Savannah Bayens, Human Ecology

Advisor(s): Rufaro Chitiyo

There is a growing sparsity of nature and a decline in how much time people spend being in nature. However, spending time in nature and green spaces has been shown to improve cognitive abilities in people as well as reduce ADHD symptoms in children (Berg & Berg, 2010; Schutte et al, 2015). I did a literature review of this topic to explain the benefits of spending time in nature. To find research articles I looked for articles related to the cognitive benefits of nature, nature's effects on ADHD symptoms and the benefit of nature elements in therapeutic activities. I included qualitative as well as quantitative research and excluded research that did not have an element of spending time in green spaces. Results from the literature review showed increases in cognitive abilities such as increased focus when participants spent time in nature areas. It also showed decreases in ADHD symptoms in children when they spend time outside in nature areas versus being inside or in urban areas. These findings demonstrate the importance of spending time outside in nature areas to help increase cognitive function and reduce ADHD symptoms in children.

Undergraduate

*CURRENT PROFESSIONAL OPINIONS ON THE USE OF CHILD RESTRAINT

Primary Author: Abby Bowen, Human Ecology

Advisor(s): Rufaro Chitiyo

The use of child restraint in the medical setting is an essential topic of discussion. This topic is important because, not only are there physical and psychological risks for the child who is being restrained, but there are also critical ethical implications for medical staff that come along with the use of restraint. While the use of restraint may be unavoidable at times, therapeutic holding should always be used if at all possible due to the risk factors

presented by the use of restraint. It is important to note that restraint should only be used when the health and safety of the child and/or staff is in question. When searching the literature, I used the key terms “child restraint” and “therapeutic holding.” It is also imperative to understand the similarities and differences between these two terms. Overall, there is a time and place for child restraint in the medical setting, but there must be communication and training with medical staff to understand the purpose and the appropriateness of its use, as well as the alternatives.

Undergraduate

*BENEFITS OF PLANT-BASED DIET AND RISK OF CARDIOVASCULAR DISEASE

Primary Author: Makayla Brown, Human Ecology

Advisor(s): Samantha Hutson

The purpose of this review is to explore whether or not a high intake of fiber from a plant-based diet has a beneficial effect on the prevention of cardiovascular disease. Cardiovascular disease is the number one leading cause of death in the United States, and the prevalence continues to increase. Interventions need to be pursued in order to prevent an individual from becoming diagnosed with this life-threatening disease and to treat those already diagnosed. The research that contributed to this review focused on a plant-based diet with an emphasis on fiber intake and how it affected the development and treatment of cardiovascular disease. Databases included the Journal of the Academy of Nutrition and Dietetics, PubMed, Medline Plus, and Mayo Clinic. A vegetarian diet can be healthful, nutritionally adequate, and provide benefits that can reduce the risk of certain diseases, including cardiovascular disease. Adequate dietary fiber consumption can lead to many benefits on health. It can reduce the risk of several chronic diseases, such as cardiovascular disease, type 2 diabetes, and some cancers. A diet that is high in animal derived foods lead to large consumption of unhealthy fats and thus can have a negative effect on heart health. Researchers showed evidence suggesting that a plant-based diet can be beneficial while animal-based products are detrimental. It is likely possible that a vegetarian diet high in fiber can be beneficial in reducing the risk of cardiovascular disease.

Undergraduate

*PHYSICAL AND DIGITAL PLAY: IMPACT ON CHILDREN'S DEVELOPMENT

Primary Author: Kirbi Buchanan, Human Ecology

Advisor(s): Rufaro Chitiyo

While play seems to be such a simple thing children engage in, it is an essential part of the development of a child. There are many types of play children can engage in and looking directly at physical and digital play will help understand the negative and positive impacts of play on the development of a child. When conducting a literature review on this topic, I included key terms that were specifically focused on the types of play as well as how play positively and negatively contributes to development; I avoided topics that did not include the impact on development. I found qualitative research and secondary articles that specifically covered my topic. Understanding the importance of how different types of play can impact a child’s development will hopefully help people to be more supportive of children engaging in play. Most people see play as just a normal thing children do, but looking further into play creates an understanding that play can impact a child’s development.

Undergraduate

*IMPACT OF DIET AND PHYSICAL ACTIVITY ON BREAST CANCER SURVIVORS

Primary Author: Hailee Cantrell, Human Ecology

Advisor(s): Samantha Hutson

With technological advancements, the number of breast cancer survivors is increasing. However, research shows that these women are not getting the education they need to prevent recurrence of cancer and improve their quality of life during recovery. The purpose of this review of literature was to examine how diet and physical activity impacted breast cancer outcomes during recovery. Results indicated that breast cancer survivors lack education on lifestyle strategies to decrease their risk of cancer recurrence. This population was also shown to have benefited when they ate a nutritionally dense diet and exercised regularly. Research found that a healthier diet was associated with lower levels of inflammation and therefore improved breast cancer survival during recovery. In one study, results showed that telomeres, oligonucleotides that shorten due to normal cell death, shortened in the 'usual care' group and lengthened in the intervention group. The intervention group participated in behavioral counseling, reduced caloric intake, and increased physical activity while the 'usual care' group did not. Diet and exercise can impact outcomes during breast cancer recovery. Overall, breast cancer survivors are in need of evidence-based, dietary and physical programs to help them reduce the risk or cancer recurrence as well as helping maintain their overall health.

Undergraduate

*PREVENTING CHILD ABUSE

Primary Author: Makayla Carter, Human Ecology

Advisor(s): Rufaro Chitiyo

Child abuse is something we all know is occurring, but very few of us know how to help. A child abuse report is made every ten seconds, and America actually has one of the worst records among developed nations (ChildHelp, 2014, p. 1). There are enough child abuse victims to fill an entire football stadium ten times. On average, four to seven children are lost everyday due to child abuse and neglect(ChildHelp, 2014, p. 1). Some quantitative research fore this literature review, however the lack of research on this topic despite the prevalence shows how needed this research is. The studies I found showed the prevalence of child abuse, how it can be identified through behavior, and effective ways for it to be prevented based on that behavior. Through this knowledge, we can help reduce the risk and occurrence of child abuse while also intervening on child abuse that is already happening.

Undergraduate

*ASSOCIATION BETWEEN A HEALTHY AND BALANCED NUTRITIONAL INTAKE IN RELATION TO SELF-CARE AND DEPRESSION

Primary Author: Soyoung Choi, Nutition and Dietetics

Co-Author(s)/Collaborators: Dr. Samantha Hutson

Advisor(s): Samantha Hutson

Depression is a mental illness that can negatively impact one's overall quality of life. As of 2017, more than 300 million people across the globe and 17.3 million adults in the United States experienced symptoms of depression. The purpose of this review of literature is to explore the association between a healthy and balanced nutritional intake with self-care and depression. A deficiency in antioxidants, a shift in oxidative stress markers, and inflammatory markers in the body act as modifiable risk factors for depression. The Mediterranean diet is rich in antioxidants and anti-inflammatory effects; obesity, smoking, sleep deprivation, and poor diet choices are lifestyle and psychological stressors that can be combated by the anti-inflammatory effects of this diet. The adult hippocampal neurogenesis (AHN), identified to have a direct influence on cognitive abilities and mood, can be regulated to prevent decreased AHN, which coincides with depressive behaviors. Also, nutritional psychiatry is a new field of research that could lead to influential dietary approaches for disease prevention and exploration of therapeutic goals for mental illnesses, such as depression.

Increased awareness is needed and socially normalizing depression and mental illnesses should be advocated for and promoted by policy makers, health care providers, family members, and educator figures in order for further research to be conducted to explore in what ways nutrition can affect self-care when diagnosed with depression.

Undergraduate

*IMPACT OF LOGGING PRACTICES IN THE SOUTH EASTERN UNTIED STATES

Primary Author: Kade Copeland, Agriculture

Advisor(s): Rufaro Chitiyo

Logging is a huge industry in the United States, especially in the south eastern region. Logging provides us with goods that are essential for every day life, such as paper products. In the past, loggers just used any means necessary to harvest the wood with no concern of the environment for the future. In recent years, loggers and foresters have developed different methods of harvesting. These practices and harvesting methods have been designed with conservation in mind. This makes these practices superior to practices of old because conservation is the main focus instead of production. Practices have also been created to lessen resource concerns caused by heavy equipment. Research has been and is in the process of being conducted on which of these logging practices and methods are the best for the environment. The goal of this research is to find out how these different logging methods and practices conserve the environment. Another goal is to find out which logging practices are best for the environment. Without this knowledge, we may be endangering our natural resources for future generations by logging.

Undergraduate

*CHRONICALLY ILL CAREGIVERS' PERSPECTIVES ON PARENTING

Primary Author: Hailey Craig, Human Ecology

Advisor(s): Rufaro Chitiyo

This poster is an examination of different studies that relate to youth adjustment to parental illness, caregiver chronic illness, parental interventions as well as standings of parents with chronic illnesses. This poster focuses on the perspectives that caregivers with a chronic illness share about parenting and how it has affected their parenting style. For the sake of this project, chronically ill is defined as a situation whereby a person is unable to commit to regular daily tasks and is affected negatively by this illness daily. By this definition, the population of the studies reviewed for this poster face chronic illness while parenting or in some aspect of caregiving. This poster also examines relevant studies that focus on families (children, siblings, parents, etc.) dealing with chronic illness in some capacity. The research reviewed for this project is important and relevant to discover what resources work for caregivers with chronic illnesses and disabilities, not only so professionals can adapt to the needs of these individuals but to also apply the resources available to this population.

Undergraduate

*EXPLORING ENERGY SYSTEMS AND SUPPLEMENTATION OF BETA-ALANINE IN ATHLETIC POPULATIONS

Primary Author: William Hall, Human Ecology

Advisor(s): Samantha Hutson

This review of literature examined the performance effects of beta-alanine supplementation in an athletic population. For the purpose of this study "athletic population" was defined as anyone who is exercising and supplementing beta-alanine, the goal was to determine if there was improvement in athletic performance within each of the three energy systems. Energy systems were defined by the National Strength and Conditioning Association as the

phosphocreatine system, glycolysis system, and oxidative system. The research that was included determined how much beta-alanine was supplemented, the duration of supplementation, and whether it increased performance. A cost analysis was based on an average of three leading retailers for the supplementation of beta-alanine. In conclusion, there is evidence to indicate that beta-alanine supplementation increases performance within two of the three systems, but would encompass the entire range given for the glycolysis system and would slightly range in the lower end with the oxidative system. There was no determination regarding how much of an increase in performance was seen. With the analysis of cost compared with increased performance given the range of dosages and length of supplementation in the various studies it would cost approximately $12.16 to $25.20 a month to see an increase in performance.

Undergraduate

LIFESTYLE FACTORS ASSOCIATED WITH REPRODUCTIVE HEALTH IN WOMEN

Primary Author: Katie Hoskins, Human Ecology

Co-Author(s)/Collaborators: Samantha Hutson, Tennessee Technological University

Advisor(s): Samantha Hutson

There are factors that should be considered in the years leading up to pregnancy, (or attempts to become pregnant) such as contraception use, diet, and perhaps most importantly - physical activity levels and components of metabolic syndrome [large waist circumference, low HDL, high triglycerides, high blood pressure, and high fasting blood sugar], which is what this review of literature focused on. According to the Centers for Disease Control and Prevention, approximately 12% of married women experience infertility. While the cause of infertility may be unknown to an individual, there are certain conditions associated with decreased fertility. For example, polycystic ovarian syndrome (PCOS) is the leading cause of infertility in women. PCOS is one of the most common endocrine and metabolic disorders in premenopausal women. In addition, many lifestyle factors in the years leading up to conception can be modified to improve a woman's chances of becoming pregnant. Research reviewed in this paper discussed how lifestyle factors such as obesity, physical inactivity, and an unbalanced diet pattern can affect a woman's reproductive health. In addition, this research indicated that a healthy body mass index, engaging in physical activity, and a balanced diet can positively improve a woman's reproductive health. Indirect risk factors of infertility include obesity, physical inactivity, and metabolic disturbances. Physical inactivity is related to all of the previously mentioned disorders, which is why physical activity is the most important factor in a positive fertility status.

Undergraduate

*THE USE OF IMMUNOLOGICAL MARKERS MEASURED FROM CELL CULTURE AND BLOOD SERUM TO GAUGE THE ANTIINFLAMMATORY EFFECT AND THERAPEUTIC APPLICATION OF FOOD

Primary Author: Kayla Monet Hotaling, Nutition and Dietetics

Advisor(s): Samantha Hutson

Dietary practice focuses on recommendations for anti-inflammatory foods and their therapeutic effects to treat, correct, or prevent pathological damage from diet and lifestyle. Research has had inconclusive proof of their anti-inflammatory effects by merely clinical correlation between disease and serum antioxidant levels. The purpose of this paper was to examine research that has used advancement in measuring immunological biomarkers to test anti-inflammatory effects and therapeutic uses of these foods. As immunological pathways are directly responsible for inflammation, it seems logical to study and measure

anti-inflammatory foods' impact on these pathways. This paper summarised the results of 9 articles that measured the effect of foods on biomarkers histamine, IgE, FcεRI receptors, among others. Measuring these biomarkers, each article found mostly significant reduction in inflammation. Some studied a step further, using an extract of the food to treat induced inflammation and often found that some applications of the food did have a therapeutic effect. These conclusions are cautionary as there are as yet few articles published on few foods. There is not enough data yet to make recommendations for the ideal application of therapeutic foods. More research needs to be done in this area. Dietetics researchers have an opportunity to get involved in the data collection needed to quantify a food's anti-inflammatory effect and best therapeutic practice.

Undergraduate

EXPLORING THE RELATIONSHIP BETWEEN PROBIOTIC SUPPLEMENTS AND IRRITABLE BOWEL SYNDROME

Primary Author: Emily Landrum

Advisor(s): Samantha Hutson

This review of literature explored the relationship between probiotics supplements and Irritable Bowel Syndrome (IBS). The purpose was to determine whether the inclusion of probiotic supplements containing Lactobacillus Plantarum and Bacillus Coagulans improve the symptoms in individuals with Irritable Bowel Syndrome. Irritable Bowel Syndrome is one of the most common functional gastrointestinal disorders worldwide and presents a number of negative symptoms such as bloating, constipation, and diarrhea. There is no one clear cause of IBS but one suspected cause is an overgrowth of bacteria in the Gastrointestinal tract or disruption in the microbiome. With this in mind, treatments may include probiotic supplementation for IBS in order to manipulate the microflora present in the gut to improve symptoms. The results of the study indicated that probiotics administered at a higher dose were more effective at relieving symptoms. Lactobacillus Plantarum 299v had mixed results likely due to a placebo effect. Bacillus Coagulans was an effective treatment for IBS Diarrhea and IBS Mixed, but not IBS Constipation. Based on current research probiotic supplements may be effective at relieving symptoms of irritable bowel syndrome, but the colony-forming unit count, strain, supplement type, and treatment for each type of IBS should be considered.

Undergraduate

ASSOCIATION BETWEEN SOCIAL MEDIA AND EATING DISORDERS

Primary Author: Alyssa Lewin, Human Ecology

Advisor(s): Samantha Hutson

Over the last 10 years major social media outlets have exponentially grown in popularity. Facebook was created in 2004, Twitter in 2006 and Instagram in 2010. Instagram is currently used by 53% of American young adults (aged 18–29 years) with internet access. The purpose of this research paper focused on whether social media was associated with an increased risk of anorexia and orthorexia nervosa. Research reviewed indicated that a potential connection exists between social media use ad eating disorders. Orthorexia nervosa, as well as anorexia nervosa, is also associated with significant dietary restrictions, malnutrition, and social isolation. A higher prevalence of orthorexia nervosa is found in yoga instructors (86%), dietitians (41.9%), nutrition students (35.9%), and exercise science students (84.5%). Attempts should be made to make young people aware of the trustworthiness of online information about beauty and healthy lifestyles. Parents, educators, and health practitioners should be aware of the potential risk of online pro-eating disorder content for healthy children and teenagers. The possibility of a relationship between disordered eating behaviors and attitudes and exposure to and use of images in the mass media is widely acknowledged. Research may indicate an

association between social media use and increased risk of anorexia and orthorexia nervosa.

Undergraduate

*IN WHAT WAYS DOES A SIBLINGS CANCER DIAGNOSIS AFFECT COLLEGE STUDENTS

Primary Author: Annabelle McGinnis, Human Ecology Concentration: Child Life

Advisor(s): Rufaro Chitiyo

There has been great research done on how the hospital environment and illness affect a child's mental well-being but there has not been nearly enough research on how these factors affect the child's sibling's mental well-being. Children are very unique in how they process information and how they cope with unknown situations that scare them; this is why we need to study siblings in the healthcare setting. This information will help child life specialists in hospitals by letting them know areas to pay close attention to with siblings and how they can best support them. To find more information I conducted a literature review and used terms such as siblings, hospital, cancer, and mental wellbeing. I found several research-based and secondary articles to review. We need this research about siblings because the patient is not the only one stressed and needing support during a time of illness. By searching existing literature I found several articles to support that there is a need to conduct more research on siblings and how their brother's or sister's illness affects them.
Undergraduate

*EFFECTS OF EDUCATION IN PROMOTING A HEALTHY LIFESTYLE IN CHILDREN

Primary Author: Savanah Medlock, Human Ecology

Advisor(s): Samantha Hutson

This review of literature discussed the effects of education intervention within the middle to high school aged population in promoting and maintaining a healthy lifestyle. The Academy of Nutrition and Dietetics supports the fact that all children and adolescents regardless of age, gender, socioeconomic status, racial, ethnic, linguistic diversity, or health status should have access to food and nutrition programs that promote optimal development. The Academy of Nutrition and Dietetics has identified areas of focus that are crucial for the success of education intervention for students. These consist of: helping middle and high school aged students understand the importance of taking home what they learn to their families; surrounding themselves with peers who promote positive habits, and choosing healthier food options. Three programs were reviewed in this paper. All three programs have been implemented to promote healthy eating and an active lifestyle in school children: SmallSteps4Life, Mind, Exercise, Nutrition, Do it! (MEND), and FoodDudes. All programs showed improvement, measured by BMI, waist circumference, or an increase in the daily consumption of fruits and vegetables. There has been an increased focus on school funding and requirements for education regarding a healthy lifestyle. The funding provides the schools access to programs such as FoodDudes, MEND, and other related programs states or schools might support. In general, consistency and frequency of nutrition education is and will be vital for the goal of ensuring students are aware of a healthy lifestyle.

Undergraduate

*THE IMPACT OF FOOD INSECURITY ON COLLEGE STUDENTS

Primary Author: Sarah Nicolette, Human Ecology

Advisor(s): Rufaro Chitiyo

In 2017, the Feeding America statistics reported 934,310 people in the state of Tennessee experience food insecurity

(Feeding America, n.d.). It was also reported that 14.4% of the population (or 10,850 people) of Putnam County have at one point been food insecure. Food security and socioeconomic status of a household intersect with the performance of students attending college. External factors like anxiety over finances or worrying about food can have unknown implications on college completion. This review of literature poster will explore the current literature on food insecurity on college campuses and the implications it might have on students' performance. The information for this poster was compiled from a total of eight research articles collected from Google Scholar and the Tennessee Tech University databases. Current research findings show a negative correlation between the rates of food insecurity with a number of factors like student academic status, financial status, and behavior. So far there is no consensus on the severity of food insecurity on college campuses, in fact no valid measuring tool exists to assess it. Future research is needed in order to create tools that can be used to implement programs on campuses.

Feeding America (n.d.). Food insecurity in Tennessee. https://map.feedingamerica.org/county/2017/overall/tennessee/county/putnam

Undergraduate

*EXPLORING EATING, LIFESTYLE AND SLEEPING PATTERNS THAT AFFECTS COLLEGE ATHLETES

Primary Author: Jacob Parham, Exercise Science, Physical Education and Wellness (M.A.)
Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Samantha Hutson

This review of literature explored eating, lifestyle, and sleeping patterns that may positively or negatively impact long term health in college athletes. The authors of this review of literature demand that having adequate sleep of at least eight to nine hours is essential to recovery but can be difficult due to the athlete's schedule. Although athletes are provided with food, it may not be enough due to being so active and not having enough time to make healthy choices. Due to busy schedules, having a healthy lifestyle pattern can be difficult especially with school and other external factors to balance. The authors of the reviewed research noted that athletes need strong organizational and time management skills and the ability to make informed and mindful choices. The articles used in this review of literature provided tips that are practical, easy, and effective. In summary, the authors note that an athlete's long term health is influenced by the decisions they make, as well as their desire to be healthy.

Undergraduate

*HERBAL SUPPLEMENTS

Primary Author: Caraline Partin, Human Ecology

Advisor(s): Rufaro Chitiyo

Alternative medicines, specifically herbal supplements, have been increasing in their accessibility and commonality in the past few decades. In general, people believe there are more natural ways to promote healing or overall well-being. But herbal products are still not approved by the FDA. Although there have been research trials done, there is no proof that any certain natural supplement will have the same effect on different people. While researching literature about herbal supplements, I wanted to refine my search for mostly herbal supplements, essential oils, and vitamins that have been found to positively affect medical conditions, such as Attention-Deficit/Hyperactivity Disorder, cancers, pregnancy, obesity, and anxiety. While found some trials or reviews on products that significantly improved patients' circumstances, I also found that others do not always have the same outcomes or may contradict another trial done

on the same supplement. It is important for the general population to know this information, understand that there are many unknowns, and be cautious when taking herbal supplements. Natural products are often thought of as an easy answer or quick fix to a medical problem, and many of them are safe when used in moderation, but there is still no guarantee of the safety or efficacy of herbal supplements.

Undergraduate

*THE IMPORTANCE OF DIETARY SUPPLEMENTS IN CELIAC DISEASE

Primary Author: Bethany Roe, Human Ecology

Advisor(s): Rufaro Chitiyo

Celiac disease is an autoimmune disease that when gluten is consumed, the body reacts as an immune response that attacks the small intestine, causing the villi to become damaged, allowing their body to not be able to absorb nutrients like a normal healthy person should, causing the person to be malnourished and cause a lot more issues than necessary. The literature review that was done prior this, indicated that people with celiac disease is in fact deficient in multiple vitamins and minerals and is malnutrition. For instance, Amanda Liu and her team did research describing the factors influencing micronutrient supplements and dietary intake in those with celiac disease (Liu, 2018). Celiac disease is an important issue to address because it effects about three-million people in the United States alone, and the majority of those people are undiagnosed. If those individuals were diagnosed, and received the education they would need to know about this disease, know what minerals and vitamins they are deficient in, as well as what those vitamins and minerals can do to their body, they could solve a lot bigger problems down the road.

Undergraduate

*LITERATURE REVIEW: CORRELATION BETWEEN PARENTAL DIVORCE AND SUCCESS IN COLLEGE

Primary Author: Ivy Shouse, Human Ecology

Advisor(s): Rufaro Chitiyo

Children and adolescents in today's society are commonly experiencing parental divorce. Because of this, it is important to understand how parental divorce affects these children. The impact of this will affect their development, their mental health, and their educational attainment. The need to earn a higher education degree is great and college students are under immense pressure to succeed. In this literature review, research articles were found using keywords like, "parental divorce," "education," "college success," and "varying reactions." This literature review sought to find out if parental divorce is correlated to success in college. Subtopics like how to define college success, factors that negatively impact college students, and how each child varies in their reaction to parental divorce, were all explored. The research of this literature review indicated that parental divorce has a negative impact on success in college because experiencing parental divorce has a negative effect on a child's education, and when educational attainment and ambition are lowered, the chance of succeeding in college declines.

Undergraduate

*SIBLING RELATIONSHIPS WHEN ONE SIBLING HAS AUTISM

Primary Author: Madison Todd, Human Ecology

Advisor(s): Rufaro Chitiyo

Sibling relationships were examined where one sibling has autism and significant findings were recorded. Based on existing literature, there were three main deficits in the sibling relationships and these are behavior, avoidance, and communication. In this project, research is directed toward the negative impacts of sibling relationships where one sibling has autism. When searching for research on this topic, I identified quantitative and qualitative research that has been conducted, and those research articles were

assessed to be used in a literature review. Many literature reviews were also used as supporting sources for my project. Results from past studies indicate that sibling relationships are negatively impacted when one of the siblings has autism because in these relationships it is hard for the siblings to have a connection and communicate. This topic is important to research because there are certain interventions that can be used to help build the sibling relationships, and sibling relationships are important to maintain throughout the lifespan.

Undergraduate

EXPLORING THE EFFECTS OF CAREGIVER BEHAVIOR ON ADOLESCENT LIFESTYLE

Primary Author: Kenzie Williams, Human Ecology

Co-Author(s)/Collaborators: Samantha Hutson, Tennessee Technological University

Advisor(s): Samantha Hutson

The purpose of this review of literature was to explore the roles that caregivers play in the environment and organization of meals for adolescents. We have seen dramatic rises in youth health problems that oftentimes begin with poor diet choices which may be influenced by the caregiver. Different parenting styles examined included authoritarian, authoritative, permissive, and uninvolved. Each type of parenting approach may impact lifestyle choices made by children. In addition, social and economic factors have strong effects on households and are related to why many low socioeconomic status communities face greater nutritional challenges. Research has shown a higher prevalence of health problems in lower income areas. Lower income neighborhoods often have more fast food chains and convenient access to processed, nutrient poor, and inexpensive foods. Researchers proposed remedies to this problem, such as: daily exercise and limiting screen time for kids. Another solution to this problem is having more education for parents. Educating parents on how to invigorate their child's lifestyle changes such as exercise and using less stationary entertainment needs. The parent's overall knowledge on proper health choices can be furthered in order to better offset the current status quo of our adolescent health standing. By resolving the problems with our youth, we can provide a remedy to current problems and help prevent future problems from arising.

Undergraduate

*NEGATIVE PARENTING STYLES EFFECT CHILDREN'S COGNITIVE DEVELOPMENT

Primary Author: Alessandra Young, Human Ecology

Advisor(s): Rufaro Chitiyo

Parenting styles affect all aspects of a child's life, but the largest influence that parents have on their children how their parenting styles impact cognitive development. Because interactions parents have with their children at a young age, greatly affects the way that these children will behave when they enter into adulthood; people need to be aware of the long-term effects that can occur as a result of parenting styles. I conducted a literature review as a way to read over many of the research that has been conducted on this topic and to assess how parenting styles can affect the cognitive development of a child. When children become adults, they take the things that they learned from their parents and apply them to their everyday life. This includes the negative and the positives that are acquired from their parents' parenting style. Having an understanding of the effects of negative parenting styles and how they can affect young children can help to pave a new path of change in these children's lives.

College of Arts & Sciences

Department of Biology

Graduate

*FRESHWATER INSECT MEDIATED TRANSFTER OF POLYCHLORINATED BIPHENYLS TO RIPARIAN CONSUMERS

Primary Author: Peter Blum, Environmental Sciences Biology (Ph.D.)

Advisor(s): Justin Murdock

Arnold Air Force Base has a legacy of polychlorinated biphenyl contamination (PCB) in nearby streams and a commitment to monitoring its influence on people and wildlife. Assessment of potential human PCB exposure from fish has consistently established that the majority of fish fillets are below concern for at-risk groups for PCB exposure. However, these levels of risk are not translatable to ecosystems, because the majority of PCBs are dissolved in fats and most animals consume food items whole or do not avoid eating adipose tissue. Grey bats seasonally consume emergent freshwater insects from Woods Reservoir and contaminated streams, which creates risk for PCB exposure and subsequent associated toxicological issues with combatting disease and reduced reproductive output. A previous study has documented as having more than a magnitude higher PCB concentration than those of other areas of Tennessee and Kentucky, which may be due to historical contamination. We will be using estimations of emergence to assess the export of insect biomass from streams and spiders to assess trophic transfer of PCBs to riparian predators. Long-jawed orb-weaving spiders provide insight into PCB biomagnification in bats, as both species have similar aquatic food sources. By assessing the amount of aquatic insects are consumed by the bats, a spider-based PCB risk assessment can be created for local grey bats. We believe this study can help inform bat management and PCB influence on freshwater and terrestrial ecosystems at Arnold Air Force Base.
Arts and Sciences

Graduate

*NUTRIENT RETENTION IN A RECONNECTED RIPARIAN FORESTED WETLAND

Primary Author: Robert Brown, Environmental Sciences Biology (Ph.D.)

Co-Author(s)/Collaborators: Spencer Womble; ShrijanaDuwadi; Jordan Evans, Tennessee Technological University; Justin Murdock, Tennessee Technological University

Advisor(s): Justin Murdock

Restoring connections between rivers and floodplain wetlands can improve water quality downstream. The USDA Natural Resources Conservation Service's Wetlands Reserve Program (WRP) has restored many wetlands in the Lower Mississippi River Valley by increasing floodplain-river connections. We are studying water quality changes over three years in a restored agricultural wetland in western Kentucky after reconnection with a large agricultural ditch via levee breaks. Floodwater quality is being measured over 24 h as stream water flows from the levee, through the forest, and into a remnant stream channel using 11 automated water samplers to monitor particulate and nutrient concentrations, and 23 water level loggers to estimate flow paths and discharge. Results from the first flood show nutrient and particulate concentrations were higher and more variable earlier in the flood and closer to levee breaks. Total suspended solids (TSS) concentration was a strong predictor for both total

nitrogen (TN) and total phosphorus (TP) in the forest and near the remnant channel, indicating deposition of TSS is positively related to TN and TP retention. This relationship was stronger for TP than TN, and increasing N:P ratios over time show that more phosphorus was retained than nitrogen. This initial sampling event verified that nutrient retention occurs in this reconnected forest. Future work will incorporate nutrient and hydrology data from this, and subsequent floods, which will provide a more complete picture of nutrient retention provided by this reconnected wetland.

Graduate

*ALLELOPATHIC EFFECTS OF CYANOTOXIN MICROCYSTIN-LR IN GREATER DUCKWEED, SPIRODELA POLYRHIZA (L.) SCHLEID

Primary Author: Shrijana Duwadi, Environmental Sciences Biology (Ph.D.)

Co-Author(s)/Collaborators: Justin Murdock, Tennessee Technological University

Advisor(s): Justin Murdock

Microcystin-LR is the most toxic microcystin produced by the cyanobacteria Microcystis aeruginosa Kützing. Although it has widely been known that this toxin is hepatotoxic to animals, its effect on plants is still unclear. Given that this toxin acts as a protein phosphatase inhibitor, an allelopathic effect on aquatic plant growth is also possible. For our study, greater duckweed, Spirodela polyrhiza (L.) Schleid was grown in a gradient of Microcystin-LR concentrations (control, 0.1, 1, 2, 3, 4, and 5 µg/L) for four weeks. Although the results showed that final frond numbers and plant growth rates were significantly different (P= 0.0017 and P=0.0138 respectively) among concentrations, no clear concentration-dependent effects of Microcystin-LR were observed on final frond number and plant growth rate. Some plants exposed to higher concentrations had chlorotic spots and marginal necrosis. However, no significant difference (P=0.9679) was noticed for the final dry biomass of plants among different concentrations. Therefore, it appears that the growth of S. polyrhiza is not regulated by long-term exposure to Microcystin-LR at concentrations typically observed in cyanobacteria bloom.

Graduate

*TESTING THE FEBRILE RESPONSE OF SNAKES INOCULATED WITH OPHIDIOMYCES OPHIODIICOLA (O. o), THE CAUSATIVE AGENT OF SNAKE FUNGAL DISEASE

Primary Author: Cody Godwin, Environmental Sciences Biology (Ph.D.)

Co-Author(s)/Collaborators: Chris Murray, Southeastern Louisiana University; Alex Romer, Middle Tennessee State University; Donald Walker, Middle Tennessee State University

Advisor(s): Chris Murray

Snake Fungal Disease (SFD) is a fungal pathogen of wild snakes populations, predominantly in the Eastern and Midwestern United States. SFD is characterized by heterophilic granulomas that can form around the mouth and eyes with severe cases causing weight loss, impaired vision and eventual death. Researchers, making field observations, have noted early season basking from severely infected snakes. This may suggest that snakes are attempting to raise their body temperature, inducing a febrile response, to combat the mycosis. This study tested the hypothesis that the causative agent of snake fungal disease (Ophidiomyces ophiodiicola) induces a febrile and behavioral response of seeking differential basking temperature to regulate body temperature. Eastern ribbon

snakes (Thamnophis sauritus, n=30) were sham or O. o inoculated. Seven days after inoculation, snakes were tested on a thermal gradient that ranged from 40°C to 18°C. The internal body temperature of each snake was measured every 30 minutes for eight hours with a thermal probe inserted into the cloaca of each snake. Additionally, substrate temperatures, where the snake was basking, were measured every 30 minutes, using a laser temperature gun. Snakes inoculated with O. o exhibited significantly higher internal body temperatures and preferred significantly higher temperatures substrate temperatures.

Graduate

*SPATIAL AND TEMPORAL VARIATION OF UPTAKE AND RETENTION RATES OF NITROGEN AND PHOSPHORUS IN WEST TENNESSEE AGRICULTURAL WETLAND

Primary Author: Morgan Michael, Biology (M.S.)

Advisor(s): Justin Murdock

Excessive nutrient runoff from agriculture fields in the Mississippi River basin negatively affects local stream water and the Gulf of Mexico by creating hypoxic environments caused by harmful algal blooms. Strategies to reduce nutrients entering rivers has become a national priority. One strategy involves the restoration of riparian wetland ecosystems, as wetlands are important for buffering excessive nutrient runoff. My project focuses on a riparian wetland in west Tennessee, transitioning from agricultural fields to a restored wetland. Specifically, I am measuring spatial and temporal variation of nutrient retention within wetland soils/sediment. Nutrient uptake and denitrification estimates are obtained from sediment cores from two dominant habitat types, remnant forests and shallow water areas. Then cores were incubated in a controlled environmental chamber using a water flow through setup for 4 days. Nutrients and nitrogen gas samples were taken from the cores once each day, and uptake rates calculated as the difference between these measurements. After incubation, the sediment within the cores is analyzed for nutrients, organic matter content, and above/below ground vegetation. In general, nutrients are retained in the shallow water cores with time but forest nutrient retention is variable. Denitrification rates with shallow water cores increase. Overall understanding how habitat variation scale how the restored wetland is mitigating the effects of excessive nutrient runoff, is key. Given the high vegetation, water, and soil heterogeneity within wetlands, good understanding of potential spatial and temporal variability in ecosystem services is crucial to designing management practices to maximize their ecosystem function.

Graduate

*EVALUATING HOW HYDROLOGY INFLUENCES NUTRIENT RETENTION IN RESTORED FLOODPLAIN WETLANDS

Primary Author: Spencer Womble, Environmental Sciences Biology (Ph.D.)

Co-Author(s)/Collaborators: Justin Murdock; Robert Brown; ShrijanaDuwadi

Advisor(s): Justin Murdock

Floodplain wetlands are vital ecotones that mitigate nutrient pollution from the surrounding watershed. Despite their valuable role in maintaining healthy streams, floodplain wetlands have been historically drained or degraded by intense agricultural practices. The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) manages the Wetlands Reserve Program (WRP), which allows cropland to transition back to wetlands. A key WRP restoration practice reestablishes natural hydrology regimes and connectedness with the river, which in turn should improve nutrient retention. This study is evaluating the effectiveness

of hydrology restoration at increasing soil nitrogen and phosphorus uptake in 40 WRP wetland easements across western Tennessee and Kentucky. Thirty soil cores were collected from each of nine restored wetlands during the summer of 2019 (year one) and incubated in a laboratory system for 32 hours. Preliminary data suggest that both standing water and easement age can regulate nutrient removal rates with shallow water areas retaining at least three times more nitrogen and phosphorus than dry forested and herbaceous vegetation areas during initial flooding. However, after 32 hours of inundation, removal rates decreased substantially in most habitat types. Additional analyses will relate maximum potential uptake rates to soil properties. This preliminary data shows that water permanence may be important in maximizing wetland function, but differences may be a function of individual site characteristics and time since restoration.

Undergraduate

*IMPROVED TAXONOMIC IDENTIFICATION TECHNIQUES FOR CUTANEOUS MICROBIOTA OF SALAMANDERS

Primary Author: Charleston McCormick, Biology

Co-Author(s)/Collaborators: Aubree J. Hill

Advisor(s): John Gunderson

Batrachochytrium salamandrivorans (Bsal) and B. dendrobatidis (Bd) are fungal pathogens causing major conservation concern for amphibian populations in North America. Resistance against Bd infection has been observed in salamanders of the southeastern United States, and is likely due to their cutaneous microbiota. We hypothesize that Bd inhibitory bacterial symbionts of salamanders can be used to develop probiotic treatments for Bd and Bsal infections. We collected 110 bacterial isolates from cutaneous swab samples of wild Smoky Mountains salamanders, including multiple Bd inhibitors. However, previous attempts to taxonomically identify bacteria through traditional PCR-assisted gene sequencing techniques were largely unsuccessful. In fact, our results indicate that roughly 30% of the isolates were misidentified when only one primer pair was used. Our objective was to re-sequence the isolates' 16s rRNA gene in a more complete way using four pairs of internal sequencing primers. Our improved PCR protocol yielded high-quality, publishable gene sequences for all isolates. Now that isolates have been accurately identified, we may begin development of a probiotic treatment containing antifungal bacteria to treat disease caused by Bd and Bsal.
Arts and Sciences

Biology

Undergraduate

ANTIBIOTIC RESISTANCE PROFILING OF HUMAN ISOLATES OF STAPHYLOCOCCUS AUREUS

Primary Author: Jessica Smith, Biology

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Elijah Smith; Haidar Zaidan

Advisor(s): David Beck

Purpose: The goal was to test bacterial isolates to determine which, if any, were resistant to the antibiotics chosen for this project.

Background: Staphylococcus aureus and other staphylococci species are prevalent, naturally-occurring bacteria on humans (Chang-Seop, 2015). Antibiotic resistance is commonly seen in hospitals and

increasingly seen in the general public. These isolates go by abbreviations such as MRSA, VRSA, and LRSA (methicillin resistant S. aureus, vancomycin resistant S. aureus, and linezolid resistant S. aureus.) In addition to traditional antibiotic resistance, another form of resistance is slow growth. When an organism grows very slowly the effect of antibiotics is significantly reduced.

Methods: To characterize antibiotic resistance of human isolates of S. aureus and S. epidermidis a minimum inhibitory concentration assay (MIC) was used. A stock solution of each antibiotic was prepared as needed to have wells both above and below MIC concentration. Isolates were cultured from frozen stock vials and used within 48 hours for determining the MIC assay. The stock cultures were prepared from human isolates frozen to make stock vials; this minimizes laboratory adaptation of the isolates. All tested isolates were sub-cultured less than 4 times. After preforming the appropriate dilutions and inoculating the plates and isolates and control bacteria, the plates were incubated overnight at 37°C. The results were then be measured with a BioRad iMark Microplate Reader. Assays were performed three times to ensure reproducibility.

Results:
10.1% of isolates were MRSA
7.2% were resistant to ceftriaxone
No isolates were resistant to triclosan

Department of Chemistry

Graduate

*AN AUTOMATED APPROACH TO IN-SYRINGE DISPERSIVE LIQUID-LIQUID MICROEXTRACTION

Primary Author: Matthew Bown, Chemistry (M.S.)

Advisor(s): Andrew Callender

Dispersive liquid-liquid microextraction (DiLLME) is an extraction technique developed over the last decade, with practical applications in both qualitative and quantitative analysis. The technique typically involves addition of small volumes of organic solvent to an aqueous sample, under conditions which favor dispersion of the organic phase into very small droplets. This research project develops and demonstrates an automated in-syringe DiLLME technique. The hardware platform consists of a home-built syringe pump with a multi-position valve that selects different liquids to be mixed in the syringe, such as a sample, buffers, extraction and dispersive solvents, and internal standards. Extracted samples are dispensed into separate vials for analysis by chromatography or spectroscopy. Best performance for the hardware requires optimizing voltage, current, and stepping speed for the stepper motor in the syringe pump, giving consistent and accurate volume displacement by the syringe pump. Quantitative application will be demonstrated by generating a calibration curve based on a parallel dilution of a dye standard. Qualitative application will be demonstrated by performing a previously-developed DiLLME-GC/MS method on common polyaromatic hydrocarbons (PAHs).

Graduate

*STRUCTURAL BASIS OF ASK1-MKK4-JNK3 COMPLEX

Primary Author: Kristen Carter, Chemistry (M.S.)

Co-Author(s)/Collaborators: Derek Cashman, Tennessee Technological University

Advisor(s): Xuanzhi Zhan

Mitogen-activated protein kinases (MAPKs), including C-Jun N-terminal kinases (JNK), are kinases that play a role in many cellular functions including apoptosis, differentiation, and survival. Mitogen-activated protein kinase kinases (MKKs) are enzymes of MAPKs, and

MKKs are enzymes of mitogen-activated protein kinase kinase kinases (MAP3Ks). Our research aimed to determine the structural basis of the three-tier cascade interface of the interaction between MKK4 and its upstream MAP3K, ASK1. Here, an ASK1-MKK4-JNK3 complex, which was previously constructed by computational strategy, was simulated to analyze the dynamics of these three-tier kinase complexes. Furthermore, the major interfaces between ASK1 kinase domain and MKK4 kinase domain were verified by direct interaction assays. To study the three-protein complex, the simulation was run using nanoscale molecular dynamics (NAMD) and analyzed using visual molecular dynamics (VMD). The results showed that the complex is stable and the ASK1 interactions were determined. In addition, we also employed a integral computational method to exploit the interaction between ASK1 N-domain with downstream MKK4 & 7 substrates. The structural basis obtained in this study will demonstrate the molecular mechanism of ASK1-JNK cascades, which could provide the structural insights into other MAPK cascades. Further investigation is needed to fully characterize the structural basis of MAPK cascades that plays essential roles in differentiation, apoptosis, and survival as well as the many other cellular responses.

Graduate

*IMPROVING THIOL SPECIFIC LABELING EFFICIENCY ON SITES WITH LOW SOLVENT ACCESSIBILITY BY SOLID PHASE LABELLING (SSL)

Primary Author: Nathan Combs, Chemistry (M.S.)

Co-Author(s)/Collaborators: Tylar Thompson; William Carroll, Tennessee Technological University

Advisor(s): Xuanzhi Zhan

Cell signaling is crucial for cellular interactions to occur properly and expediently. Due to the body's numerous available responses, many receptors bind to multiple ligands, resulting in receptors' abilities to produce various responses depending on the initial ligand to which it binds. Of the numerous receptors in the body, our research focuses on arrestin3, a scaffold protein that plays an amplifying role in signal cascades for mitogen-activated protein kinases, making it a scaffold protein. Arrestin3 has the ability to bind multiple ligands on the same site, with distinct specificity, but how this multifaceted binding occurs is currently unknown.

Fluorine-tagged NMR is widely used for protein conformational studies as it is robust, clear, quick, and consistent in determining shifts in a residue's hydrophobic character. By labeling single-cysteine arrestin3 mutants with 19F in designated residues, the chemical shift can be determined before and after binding with MAPK kinases. These shifts signify key changes in arrestin3 conformation, constructing a clearer image of its overall structure.

Unfortunately, previous labeling methods were only effective in labeling residues on the external environment of the protein, not sites with low solvent-accessibility, and required a three-day dialysis procedure, inhibiting expedient research. Solid-state labeling (SSL) is a quick, efficient, and non-denaturing method that provides a much higher labeling efficiency to residues with low solvent accessibility as well as reduces labeling time to approximately six hours instead of three days. This method optimization has produced high-quality NMR data for residues not formerly labeled efficiently or at all.

Graduate

*GEOCHEMICAL FINGERPRINTING OF NATURAL WATERS IN MIDDLE TENNESSEE

Primary Author: Bryant Davis, Chemistry (M.S.)

Advisor(s): Andrew Callender

Geochemical fingerprinting is the use of chemical species to determine the source and alteration of natural waters

that comprise various bodies of water. These chemical fingerprints are defined as specific patterns of chemical species unique to each body of water. This research examines the presence of which chemical species are most prevalent in lakes that are located on two distinct physiographic regions of Tennessee: the Highland Rim and the Cumberland Plateau, by analysis of samples via ICP-MS. Lakes from these regions of Tennessee were chosen due to differences in local geology and land use patterns that each respective lake have been subjected to since their inception. Grab samples were obtained from various areas of each lake in order to obtain a true identity of each respective reservoir. Different ratios of chemical species were then determined so that a comparative analysis could occur between each body of water. An analysis of the deionized water used in the dilutions, performed prior to analysis via ICP-MS, was also performed to confirm that differences in chemical species are present due to the differences in land use and geology that each lake is subjected to. These ratios of chemical species should indicate how local geology and land use patterns affect the chemical identity of natural waters within Middle Tennessee.

Graduate

*CLEAVAGE OF TERT-BUTOXYCARBONYL (BOC) GROUPS FROM INDOLES AND OTHER HETEROCYCLES USING AN ADDITION-ELIMINATION STRATEGY WITH 3-METHOXYPROPYLAMINE

Primary Author: Zachary Gulledge, Chemistry (M.S.)

Advisor(s): Jesse Carrick

In the pursuit of synthesizing unsymmetrical complexant molecules with frustrated Lewis pairs for potential use in SANEX-type processes, a recently published method has been developed for the cleavage of BOC-protecting groups on various deactivated substrates. Under mild conditions, BOC-protected indoles, 1,2-indazoles, imidazoles, and 1,2-pyrazoles were deprotected utilizing addition-elimination reactions with nucleophilic primary amines. In comparison to more common BOC-deprotection methods, such as treatment with mineral acids, reducing agents, or Lewis acids, these mild conditions afford a feasible means to deprotect heterocycles that are acid sensitive, thereby expanding the scope of potential protection-deprotection synthetic methodologies relevant to many branches of chemistry. Synthesis of BOC-protected substrates, condition optimization, purification protocol, and substrate scope will be discussed.

Graduate

COMPUTATIONAL ANALYSIS OF WILD-TYPE AND SELENIUM-INCORPORATED DOWN-REGULATED PROTEINS IN E. COLI

Primary Author: Austin Hill, Chemistry (M.S.)

Advisor(s): Jeffrey Boles

The addition of heavy metal amino acid analogs has long been a standard augmentation of X-ray crystallography to solve the phase problem associated with smaller atoms such as carbon, nitrogen, and sulfur. Unfortunately, the addition of such analogs, like selenomethionine (SeMet), brings about unprecedented negative implications concerning the growth of the exposed cell cultures. The negative impact of growth is due to the cytotoxic effects of selenium-incorporation, either partial or complete, as seen by a proteomic analysis performed by Broderick and Boles in 2013. It is apparent that there are a marked number of completely down-regulated key enzymes in these exposed cell cultures. Many aspects of the down-regulation cannot be experimentally tested; thus, computational methodology can be utilized to provide unique insight into the cellular processes and the cytotoxic effects of selenium on proteins in vivo. An AMBER14 force field has been modified to properly model selenium atoms in the protein structure.

This modification allows for the analysis of protein stability and protein/substrate interactions of the mutant variant down-regulated enzymes.

Graduate

*SYNTHESIS AND CHARACTERIZATION OF NOVEL RHENIUM(I) COMPLEXES AS POTENTIAL PHOTOACTIVATED ANTICANCER AGENTS

Primary Author: Megan Keane, Chemistry (M.S.)

Advisor(s): Chad Rezsnyak

In recent studies, rhenium(I) complexes have shown promise to be effective anticancer agents. In particular, rhenium(I) tricarbonyl complexes have demonstrated ability as photodynamic therapy (PDT) and photoactivated chemotherapy (PACT) photosensitizers when coordinated with diimine and phosphine ligands. The phosphine ligand works to labilize the trans-carbonyl of the complex, allowing for release of carbon monoxide which permits another pathway for additional cytotoxicity. The specific compounds in question are Re(CO)3(N-N)(PR3) complexes, where N-N is a substituted phenanthroline and PR3 is a water-soluble phosphine. The synthesis and characterization (IR, UV-Vis, and multinuclear NMR) of these complexes will be described.

Graduate

*MEMBRANE TRANSPORT STUDIES OF LIQUID FORM DUAL FUNCTIONAL PROMAZINE DRUGS

Primary Author: Lillian Pipkin, Chemistry (M.S.)

Advisor(s): O. Andreea Cojocaru

Various active pharmaceutical ingredients (APIs) have been shown to benefit from conversion to a liquid form (i.e., ionic liquid or IL). These benefits include elimination of polymorphism (defined as the existence of multiple crystalline states, which is an inherent property of solid-state pharmaceuticals), increased solubility, improved bioavailability, and enhanced permeability through a skin-mimicking membrane. This strategy also affords dual functionality, which allows different pharmaceuticals in ionic form to maintain functionality of the parent drug while in combination with another drug in liquid form (i.e., active pharmaceutical ingredient ionic liquids, or API-ILs). Phenothiazine drugs (i.e. promazine) have several important biological effects, but have no inherent pain-relieving properties; as a result, they are typically administered in combination with analgesic drugs such as nonsteroidal anti-inflammatory drugs (NSAIDs). The research presented here focuses on the synthesis of novel promazine – NSAIDs dual functional API-ILs as well as on their delivery potential through a skin mimicking membrane in a Franz cell diffusion system.

Graduate

*SYNTHESIS OF ALKOXY-SUBSTITUTED 2-PYRIDINYL-BIS[1,2,4]-TRIAZINE SCAFFOLDS FOR MINOR ACTINIDE SEPARATIONS

Primary Author: Mariah Tedder, Chemistry (M.S.)

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Jesse Carrick

Recent efforts toward transitioning to renewable energy sources such as nuclear energy has resulted in a necessity for improving the handling and recycling of spent nuclear fuel. One area of research is regarding the separation of minor actinides and lanthanides from the post-PUREX raffinate. Efficient separation of these radioisotopes is crucial for downstream transmutation of this fuel into more stable isotopes. However, the lanthanides' ability to adsorb neutrons preclude their inclusion in additional fuels. This project seeks to modulate existing 2-pyridinyl-

[1,2,4]-triazine based scaffolds previously used for separations work by substituting them with alkoxy chains of various lengths. These scaffolds have demonstrated chemoselectivity toward minor actinides. However, adequate solubility in nonpolar diluents desired for use in separations work has proven challenging. An optimized three-step synthetic strategy has been employed to afford the desired complexants in moderate yields over two steps from 2,6-pyridine-bis-carbonitrile. Upon successful synthesis, these complexants will be studied for solubility and separations work in comparison to previously successful materials. Current synthetic results and preliminary solubility data will be presented.

Graduate

*IN VIVO INCORPORATION OF 19F-TRYPTOPHAN INTO JNK3 FOR NMR SPECTROSCOPY

Primary Author: Tylar Thompson, Chemistry (M.S.)

Co-Author(s)/Collaborators: Nathan Combs; Jeffrey Boles, Tennessee Technological University; William Carroll, Tennessee Technological University

Advisor(s): Xuanzhi Zhan

Among mitogen-activated protein kinases (MAPKs), the c-Jun N-terminal kinases (JNKs) are of particular interest due to their involvement in cell signaling pathways associated with diabetes, cancer, neurodegenerative disorders such as Alzheimer's, and cellular apoptosis. Focusing on JNK3 specifically, the surrounding cascade mechanisms include numerous partner enzymes that regulate its activity via phosphorylation, and these interactions alter JNK3's overall protein conformation. Understanding the movements associated with forming these complexes will shed light on the mechanism by which these enzymes act, and a deeper understanding of these signaling systems will assist in developing treatments for associated pathologies. JNK3's molecular movements can theoretically be studied with the use of 19F NMR techniques, but the JNK3 molecules must first have 19F incorporated into their structure. To that end, we will develop a method to incorporate 19F into JNK3 in vivo, then confirm the location of the labeled amino acids with 19F NMR and mutagenesis studies. After establishing a connection between each amino acid and its signal, 19F NMR can be used to study the complexes formed between JNK3 and its upstream regulatory enzymes.
Undergraduate

CONFOMATIONAL CHANGES OF JNK3 UNDER SPECIFIC AND NON-SPECIFIC BINDING OF BSA AND 5-FLUOROINDOLE

Primary Author: Brian Chong, Chemistry

Co-Author(s)/Collaborators: James Dethero

Advisor(s): William Carroll

19F Nuclear Magnetic Resonance (NMR) spectra show important information for determining molecular structure and dynamics. 19F signals are highly sensitive to changes in the local environment due to conformational changes in protein structure. This NMR technique is useful in the analysis of the JNK3 protein. JNK3 engages in several binding interactions with multiple proteins and small molecules and is involved in many cellular processes. For these reasons this protein has a great number of potential applications in biochemical research. The nature of these interactions and the conformational changes that JNK3 undergoes in binding remain elusive. This research attempts to contribute in clarifying these things. An assay for JNK3 was calibrated for non-specific binding through the evaluation of BSA's binding to 5-Fluoroindole to find the limit of detection and establish optimal NMR acquisition parameters.

Undergraduate

*EMERGENT LIQUID STATE ASTHMA MEDICATION: SYNTHESIS AND SPECTROSCOPIC CHARACTERIZATION

Primary Author: Devon Cotter, Chemical Engineering
Advisor(s): O. Andreea Cojocaru

Many asthma medications are delivered as solid state ingestible, compact tablets. Several problems arise from a drug's solid state such as low bioavailability and existence of multiple crystalline forms (polymorphism) depleting its effectiveness. The low bioavailability is related to the low aqueous solubility while polymorphic changes can convert a drug into a less or nonactive form. The effectiveness of these drugs can be enhanced by conversion into a liquid state ionic compound. Two approaches can be used: an ionic liquids (ILs) or a double salt ionic liquids (DSILs) approach. ILs and DSILs are ionic salts with MP < 100 oC; an IL is composed of a cation and an anion in a 1:1 molar ratio while a DSIL is obtained by pairing an ion with counterions in varying molar ratios (e.g., one cation with two, three, etc. anions or vice-versa). When applied to pharmaceuticals, both approaches should increase their bioavailability (higher aqueous solubility; like dissolves like), remove the existence of polymorphic forms and add multifunctionality to the final drug (i.e., the pharmaceutical activity of the parent ions is retained).

Our research focuses on synthesizing new DSILs by pairing the cationic form of albuterol asthma drug with docusate anion (a known IL former) and NSAIDs in their anionic form such as ibuprofen and naproxen anion. Albuterol hydrochloride supplies the cation source, whereas sodium docusate, sodium ibuprofen, and sodium naproxen all serve as anion sources. Our presentation will encapsulate the synthesis and spectroscopic characterization of such DSILs.

Undergraduate

*SYNTHESIS OF 2,3-BUTANEDIONE ETHYL-THIOSEMICARBAZONE

Primary Author: Huyen Dam, Chemistry

Advisor(s): Edward Lisic

Metal complexes of thiosemicarbazones have been shown in the literature to inhibit Topoisomerase II-α and could be used in potential chemotherapy treatments. A new ligand, 2,3-butanedione ethyl-thiosemicarbazone (BDMO-ETSC), was synthesized through an optimized technique to increase reaction percent yield. This synthesis utilizes 2,3-butanedione monoxime and 4-ethyl-3-thiosemicarbazide in 1% solution of acetic acid. Nuclear Magnetic Resonance (NMR) spectroscopy was used to determine the purity of the product, and only one conformation of the ligand was seen. Through this new synthesis procedure, we believe many new thiosemicarbazone ligands can be synthesized cleanly and in high yield.

Undergraduate

*SOLUBILITY OF NEW PROMAZINE DOUBLE SALT IONIC COMPOUNDS IN SIMULATED BODY FLUIDS

Primary Author: Eva Etheridge, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): O. Andreea Cojocaru

Double Salt Ionic Liquids (DSILs) are multiplex ionic compounds that melt below 100 °C, and contain more than two ions in varying molar ratios (multiple combinations of cations and anions). A DSIL can be synthesized by melting

or mixing simple ionic liquids, but it's still considered to be one single pure chemical entity. Changing the cation-anion molar ratio in a DSIL can lead to new coulombic interactions which can render new physical and chemical properties when compared to the single salt derivatives. This makes it possible for one to develop task specific chemicals in liquid form. We have previously shown that promazine, an antipsychotic phenothiazine derived drug, can be converted into DSILs when its cationic form is combined with carboxylate and docusate anions in various molar ratios.

Spectroscopic characterization showed that the degree of ionization in the novel compounds increases with increasing the concentration of the docusate anion. The research presented here focuses on investigating the aqueous solubility of promazine DSILs in simulated body fluids such as gastric fluid (pH=1.2), intestinal fluid (pH=6.8), and phosphate buffered saline (pH=7.4). This study will help with identifying a new delivery technique for the new drugs.

Undergraduate

*SYNTHESIS AND NMR CHARACTERIZATION OF NEW THIOSEMICARBAZONES

Primary Author: Ella Frost, Pre-Professional

Advisor(s): Edward Lisic

Isatin Thiosemicarbazones have been shown to have medicinal applications, including anti-tuberculosis drugs. Recently, our lab has shown that Palladium complexes of these same isation thiosemicarbazones strongly inhibit the Topoisomerase II-α enzyme, which is essential for DNA replication in dividing cells, and therefore have the potential to be used as cancer chemotherapy agents. This work shows the synthesis of new isatin thiosemicarbazones, 5-chloroisatin-tert butyl thiosemicarbazone (CI-ItBTSC) and 1-methylisatin-tert butyl thiosemicarbazone (MI-tBTSC). These new ligands have been characterized by Nuclear Magnetic Resonance (NMR) spectroscopy and show clean products for the synthesis in high yield. Now that these ligands have been synthesized and characterized they can be used to synthesize new metal complexes.

Undergraduate

*MECHANISMS OF THIOSEMICARBAZONES INHIBITION OF HUMAN TOPOISOMERASE IIALPHA

Primary Author: Clara Greer, Chemistry

Advisor(s): Xiaohua Jiang

Thiosemicarbazones (TSCs) have antiviral, antibacterial, and antifungal and antitumor activities. Human topoisomerase IIIalpha is an essential enzyme to solve the topological problems during DNA metabolism. Thus it is a popular target for anticancer drug. Recent research found that metal TSCs have inhibition against human topoisomerase IIalpha. And it seems that the metal ion plays an important role. We are examining several metal TSCs to determine their inhibition against human topoisomerase.

Undergraduate

*RAPID PRESUMPTIVE TEST KIT THAT DIFFERENTIATES BETWEEN HEMP AND MARIJUANA USING THIN LAYER CHROMATOGRAPHY

Primary Author: Courtney LaPointe, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Brooke Underwood
Advisor(s): Jeffrey Boles

The passage of the 2018 Farm Bill, legalizing cannabis containing less than 0.3% THC (Hemp), creates problems for law enforcement. Due to the presence of low levels of THCA and THC present in most commercial hemp crops, law enforcement needs to acquire the ability to distinguish between hemp and marijuana using a presumptive test kit. Our approach involves the development of an efficient, mobile, rapid thin layer chromatography (TLC) kit that provides presumptive (qualitative) forensic evidence of the chemical extract of a bud or other plant material. The evidence would later be sent to a crime lab for definitive analysis of tetrahydrocannabinol (THC) content, the psychoactive compound in marijuana. This research has focused on the utilization of TLC plates along with the spectroscopic and spectrometric identification of resolved cannabinoids. The method presented takes no more than five to six minutes to complete. The successful differentiation between fifteen lots of hemp and seven lots of marijuana will be presented along with spectroscopic and spectrometric identification of resolved cannabinoids.

Undergraduate

UTILIZING MOLECULAR MODELING TO CREATE A CANCER INHIBITING DRUG

Primary Author: Nathan Morgan

Co-Author(s)/Collaborators: Jonah Ralston

Advisor(s): William Carroll

Terpenes are commonly found in plant material and can be used to treat cancer by inhibiting Topoisomerase II-É?. If these compounds can be effectively optimized to bind Topoisomerase II-É? using information from molecular modeling techniques their efficacy can be improved. Then these molecules can be synthesized and manufactured without having to isolate them from plants. This project utilized six promising terpene structures from literature and modeled in the molecular modeling program, Molecular Operating Environment (MOE). Terpene - Topoisomerase II-É? docking scores were compared to previous findings. An analysis of ligand interactions was then made to find a way to modify the functionality of these terpenes. This method was used to propose a molecule that optimally binds to Topoâ??s active site as an inhibitor, with the intent to move forward into synthesis, binding studies, and then medical trials to combat cancer.

Undergraduate

*DETERMINING LEAD CONCENTRATIONS IN WATER USING GREEN ELECTROCHEMISTRY

Primary Author: Jonathan Murray, Biochemistry

Advisor(s): Jonathan Moldenhauer

The electroanalytical capabilities of a poly(3,4-ethylenedioxythiophene)/poly(4-styrenesulfonate), or PEDOT/PSS, modified gold working electrode were evaluated using two different techniques, cyclic voltammetry (CV) and differential pulse stripping voltammetry (DPSV), to determine various lead (Pb) concentrations in an aqueous solution. A gold electrode was selected to be polymerized with EDOT over the traditional mercury thin film electrode as polymerization of EDOT is a greener method. The method does not involve organic solvents, and the polymerization allows for conjugation of the polymerized EDOT backbone which provides electrical conductivity. Initial polymerization is accompanied with sodium dodecyl sulfide (SDS) which increases thiophene solubility and decreases oxidation potential. By later modifying the PEDOT electrode with PSS, the anionic nature of the electrode increases. Furthermore, a bare gold electrode, or even a gold PEDOT electrode, would not allow for the lead to be easily stripped off; however, the PEDOT/PSS electrode allows for the process to occur with greater success. The PEDOT/PSS working electrode was used alongside a platinum counter electrode and a

Ag/AgCl reference electrode in each experiment. Both techniques allowed for specific detection of the analyte in an aqueous KNO3 electrolyte solution. DPSV, however, provided more accurate and detailed results than the CV was able to produce. The DPSV method allowed for a lower concentration limit, and further optimization, specifically focused on the time and electroplating step may lead to an even lower limit.

Undergraduate

*CONTROLLED RELEASE OF JUGLONE IN ACIDIC MEDIUM FROM HYDROPHILIC MESOPOROUS SILICA

Primary Author: Rachel Paris, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Andreea Cojocaru

Advisor(s): Twanelle Majors

Juglone is an organic compound that has many valuable properties, such as antimicrobial, herbicidal, and medicinal. Unfortunately, purchasing and using synthetic juglone is expensive, with Sigma Aldrich selling 5 grams of juglone 97% purity with $177. Walnut hulls are a natural source of juglone. Utilizing the plant sourced juglone could be a sustainable way to reuse waste plant materials such as walnut hulls and more advantageous due to lower costs. Like many other chemicals with beneficial properties, juglone also has some side effects: it's toxic to some cash crops and freshwater organisms and it can negatively affect these them through runoff. Thus, its leaching must be controlled. One direction of our research is to find methods for controlled delivery of plant-sourced juglone as an herbicidal or microbial agent. We have previously shown that the commercially available juglone can be loaded on a solid support such as hydrophilic mesoporous silica in different wt/wt% loadings (10, 20, and 50). The research presented here focuses on the leaching of juglone from silica solid support into aqueous environments with pHs similar to soil pHs. The methodology developed here will be further utilized to develop new laboratory investigations for non-majors chemistry courses and high school chemistry courses so that laboratory experiments will be more rigorous and more relevant to the everyday experiences and majors of these students.

Undergraduate

ADSORPTION CHARACTERISTICS OF A THIOSEMICARBAZONE CHELATING RESIN FOR SEPARATIONS OF TOXIC ELEMENTS FROM AQUEOUS MEDIA

Primary Author: Savannah Pollard, Chemistry

Co-Author(s)/Collaborators: Edward Lisic

Advisor(s): Cory Hawkins

An anion exchange resin has been functionalized with the chelating ligand 1,2- Naphthoquinone-4-Sulfonic Acid Phenyl Thiosemicarbazone. Previous studies have characterized the adsorption of cadmium, nickel and cobalt on this resin using radiotracer techniques. Elements of interest in environmental water contamination include cadmium, lead and arsenic. Batch analysis is being carried out to understand the extent of adsorption of these elements (with cadmium as a known solute) onto the resin under conditions that represent the load, wash and elution stages of a column separation. Arsenic and lead lack useful radiotracers for phase partitioning measurements. Therefore, the measurements are being accomplished using inductively-coupled plasma mass spectrometry (ICP-MS). Trends in the pH dependence of solid-liquid distributions are expected to vary depending on the soft acid character of the metal ions and their charges. Adsorption differences

between the metal ions and arsenate are of particular interest, because the arsenate anion may be strongly retained if residual anion exchange sites are available. The results of this study are intended to inform the design of column separation procedures for preparation of samples from natural waters.

Undergraduate

SYNTHESIS OF AN SESQUITERPENOID CADINANE-TYPE MOLECULE

Primary Author: Jonah Ralston, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborators: Nathan Morgan

Advisor(s): William Carroll

This research involves the synthesis of a terpene, a class of volatile organic compounds, for chemotherapeutic uses. Terpenes are volatile organic compounds often found in many plants and have been studied for their vast medicinal uses, often in cancer research. Their stereochemistry is what often makes the molecules so interesting for their medicinal applications in binding to proteins such as topoisomerase. It is believed that certain terpenoids can bind to active sites on proteins like topoisomerase to help prevent cancer growth. With this, the design of a cadinene-type terpenoid came to be in order to bind to topoisomerase. With modeling and the structure of a terpenoid backbone, a terpenoid can be synthesized to better bind to topoisomerase for the use of chemotherapeutics.

Undergraduate

EFFICACY OF SYNTHESIS-TYPE QUESTIONS IN PREDICTING STUDENT SUCCESS IN GENERAL CHEMISTRY

Primary Author: Ashley Rector, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Advisor(s): Chad Rezsnyak

Summative assessments are used to evaluate student mastery of the content relative to the other students in the course. Individual items on assessments are often constructed to evaluate students' knowledge on one particular topic. Many practical problems facing scientists cannot be solved with a single skill, but rather require a sequence or combination of individual skills. In the context of General Chemistry, the highest achieving students in the course are those that should be able to integrate fundamental skills to solve more complex problems. In this study, synthesis questions (items incorporating a combination of individual skills) were incorporated into the hour exams given to students in a General Chemistry course (n = 750) to evaluate whether the higher performing students were more successful on these types of questions, and therefore whether success on synthesis-type questions correlates with student course outcomes. The results will be evaluated to determine whether student success on the individual skills correlates with success on questions involving a combination of those skills. Results will be contextualized and analyzed with regards to student demographics and past performance on standardized exams.

Undergraduate

*QUINIDINE AND QUININE BASED DOUBLE SALT IONIC LIQUIDS

Primary Author: Thomas Robertson II, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: O. Andreea Cojocaru, Tennessee Technological University

Advisor(s): O. Andreea Cojocaru

Injury caused by medications is the leading cause of death in the United States. Drug induced liver injury is any form of liver injury caused by primary or alternative medication. A potential solution to prevent liver injury is the pairing of these drugs into one single compound in liquid form: an active pharmaceutical ingredient (API) and an FDA approved compound, or two APIs, can be combined in their cationic or anionic form into a single ionic compound leading to the formation of new dual active APIs in liquid form (aka ionic liquids that melt below body temperature). These newly formed liquid drugs are able to retain the pharmaceutical properties of the original APIs. Moreover, the combination of three or more drugs into a single ionic compound, namely a double salt ionic liquid would allow one to add additional properties (such as transdermal delivery) to the final liquid drug. Our research focuses on applying the ionic liquids strategies to quinidine (QD) and quinine (QN), two drugs known to cause liver injury, by pairing them with drugs that offer liver protection properties (e.g., N-acetyl-L-cysteine or NALC) and with compounds that will increase their transdermal permeability (e.g., sodium docusate or NaDoc). Here we show the synthesis and spectroscopic characterization of new double salt ionic compounds obtained by combining QD or QN cations with NALC and Doc anions in different cation to anion molar ratios.

Undergraduate

*ELECTROACTIVITY OF JUGLONE IN BUFFERED ETHANOL MIXTURES OF SOIL-LIKE PH

Primary Author: Cory Rogers, Chemistry

Co-Author(s)/Collaborators: Jonathan Moldenhauer; O. Andreea Cojocaru

Advisor(s): Twanelle Majors

In the leaves, hulls, and roots of the black walnut tree, Juglans nigra, exists juglone (or 5-hydroxy-1,4-napthoquinone). Juglone, with molecular formula C10H6O3 and molar mass 174.15g/mol, has many applications in science. These include anti-microbial and anti-fungal application against pathogens, herbicidal function against foreign plant species, and use as natural dyes. While juglone is very versatile, it is rather challenging to detect. Spectroscopy alone tends to be insufficient in solely determining presence and concentration of juglone in a sample. This is due to the presence of several phenolic and polyphenolic compounds in a given walnut extract. Understanding how to better detect the presence of juglone in a standard stock solution or in a naturally acquired sample furthers the development of juglone extraction and related application in a scientific setting. The objective of this research was to continue studying the electrochemistry of juglone in 1:1 aqueous buffer:ethanol mixed solutions using cyclic voltammetry to assess electroactivity of standard prepared juglone solutions. Specifically, a focus on pH values that mimic soil pH in the native region of the black walnut tree was employed in an attempt to understand how juglone acts in an environmental setting.

Undergraduate

*USING COLOR CHANGING CANDLES TO DECREASE THE HAZARDS AND INCREASE THE ACCESSIBILITY OF THE RAINBOW FLAME TEST

Primary Author: Abigail Rossi, Chemistry

Advisor(s): Amanda Carroll

Colored flames like those in the rainbow flame test are fascinating for all ages and can spark meaningful

conversations about chemistry concepts. However, the rainbow flame test can be very dangerous, a fact too often ignored by those wanting to see the flame change colors. Previous work found that the safety of this demonstration could be increased by introducing aqueous solutions of salts into the flame via small spray bottles. The largest safety hazard that remains is the use of gas to produce the flame in a Bunsen or Meker burner. A potential solution to this issue is a color-changing candle, one that still exhibits a color related to a metal ion that can be used for demonstration purposes. Through using a small candle that already contains a salt the need for a gas source is eliminated, as well as the need to introduce the ions into the flame. These candles could easily be prepared by teachers and hold the potential to provide a safer means of conducting this demonstration over a long period of time, which would increase the accessibility of this demonstration to educators with limited time and resources.

Undergraduate

*ADDING SOLID HANDLING TO LIQUID STATE THIORIDAZINE DRUGS

Primary Author: Claire Rust, Chemistry

Advisor(s): O. Andreea Cojocaru

Solid state drugs encounter issues related to polymorphism (conversion into different crystalline structures with different reactivity) or low bioavailability (low aqueous solubility due to their hydrophobic nature). Converting these solid drugs into an ionic liquid state will address the indicated issues and add new, more favorable properties such as multifunctionality. However, liquid state drugs can be highly viscous, leading to difficulties in handling. Supported ionic liquid phases (SILP) strategy (i.e., adsorption of a compound on the surface of a solid support) adds a solid handling advantage to the highly viscous liquid state compounds. Thioridazine is a solid state phenothiazine pharmaceutical that exhibits side effects such as cardiac arrythmia. By combining thioridazine cation with lidocaine cation (an antiarrhythmic drug) and docusate anion into a new liquid state compound, namely a double salt ionic liquid (DSIL), these side effects may be eliminated. However, the issue related to the high viscosity remains. This issue can be eliminated and the new drug can be delivered into the body using SILP strategy. This presentation shows our effort towards the formation of new SILP materials by adsorbing/loading thioridazine DSILs onto hydrophilic silica solid support. Silica was used for its known eco-friendly properties in medicinal delivery. Through an adjustment of amount of the drug loaded on silica, several loadings were investigated.

Undergraduate

*DIVING IN WITH ICP-MASS SPECTROMETRY

Primary Author: Emma Schrider, Chemistry

Co-Author(s)/Collaborators: Chance Morris; Andrew Callender

Advisor(s): Andrew Callender

The intent of this project is to quantitatively analyze the human impact on systems of water and the environment, specifically looking at samples around locations suspected of higher pollution. Inductively coupled plasma mass spectrometry (ICPMS) is an analytical technique able to detect low concentrations of metal/nonmetal ions with high sensitivity. Samples were collected in Oak Ridge, Norris, and Gallatin, TN. Nitric acid was used to stabilize the metal/nonmetal ions in tap water and the natural water samples collected until analyzed via ICPMS. It is predicted that natural water sampled near the sources of anticipated pollution will have a higher concentration of heavy metal ions than the tap water or water sampled further away from said sources.

Undergraduate

*REACTION OPTIMIZATION USING DESIGN OF EXPERIMENT (DOE) AT THE NMR SCALE

Primary Author: Kyle Schulmeister, Chemistry

Co-Author(s)/Collaborators: Nathan Morgan

Advisor(s): William Carroll

Scientists in the chemical industry are interested in ways to produce substances with the highest possible efficiency. Significant developments have been achieved in the past twenty years, in particular with a technique known as Design of Experiment (DOE), which differs from the traditional One Variable at a Time approach to optimization. The DOE approach determines what experimental factors are most influential on the yield of the reaction, then optimizes those factors. This project attempts to develop a cheap and simple way to optimize reactions. This can be achieved at microscale to reduce costs, make the method easily deployable, and simple for a large number of samples. This project uses Nuclear Magnetic Resonance (NMR) spectroscopy to observe reactions at this scale. Using NMR allows the reactions to be closely monitored as they proceed. The process can be applied to organic chemistry labs as a way to demonstrate DOE, as well as applied to other more practical synthetic challenges.

Undergraduate

SYNTHESIS OF NEW OXAZOLE THIOSEMICARBAZONES AND THEIR REACTIONS WITH PALLADIUM (II)

Primary Author: Kaitlyn Stiles, Chemistry

Co-Author(s)/Collaborators: Sam Frizzle; John Maynard; Pat Pangle

Advisor(s): Edward Lisic

Thiosemicarbazones have been used in the medicinal field for several decades. Metal complexed thiosemicarbazones have been recently introduced to the medicinal field as possible anticancer drug options. Our group is working to synthesize a series of metal-complexed thiosemicarbazones for the purpose of interacting with the Topoisomerase (II) α enzyme, which is necessary for DNA and cell replication, to slow the advance of cancer cells. The compounds we synthesized are (1) 2- benzoyloxazole-ethyl thiosemicarbazone (BZOX-ETSC) and 2- benzoyloxazole-tertbutyl thiosemicarbazone (BZOX-tBTSC). The most recent synthesis attempt of BZOX-ETSC with sodium tetrachloropalladate(II) has shown promising results.

Undergraduate

*AQUEOUS SOLUBILITY OF NEW ALBUTEROL DRUGS IN LIQUID FORM

Primary Author: Jacob Thorn, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): O. Andreea Cojocaru

One of the most recurrent issues encountered in the world of active pharmaceutical ingredients (APIs) is their low bioavailability, in part due to their poor dissolution in aqueous media. Multiple studies have shown that the conversion of the solid-state pharmaceuticals into liquid-state or ionic liquids (ILs, ionic salts in liquid-state comprised of a 1:1 cation to anion molar ratio) is one of the most promising routes to address these issues. Increasing a drug's solubility can be also achieved when three or more pharmaceuticals are combined in different molar

ratios into a more complex IL, namely a double salt ionic liquid (DSIL). Albuterol is very commonly used to control acute asthma attacks. Due to its structure, the aqueous solubility of albuterol is low, and its bioavailability hence is diminished. However, albuterol contains a basic amine site making it an ideal candidate for conversion into cationic form which can then be paired with organic anions to form new liquid state asthma medication. Our previous research showed that the albuterol cation, a non-steroidal anti-inflammatory drug anion, and docusate anion can be successfully combined in different molar ratios to form the corresponding DSILs. Here, our research efforts are directed towards the aqueous solubility of the IL albuterol derivatives. Solubility studies were performed in phosphate buffered saline (PBS, an aqueous medium that mimics the ionic concentration, osmolality, and pH of blood) by following the reported procedures and the amount of the desired compound in the aqueous solution was quantified via UV-Vis spectroscopy.

Undergraduate

*A RAPID LIQUID-LIQUID EXTRACTION BASED PRESUMPTIVE TEST THAT DIFFERENTIATES BETWEEN HEMP AND MARIJUANA

Primary Author: Brooke Underwood, Chemistry

Co-Author(s)/Collaborators: Courtney LaPointe

Advisor(s): Jeffrey Boles

Passage of the Farm Bill in December 2018 legalized cannabis containing less than 0.3% THC (Hemp). This creates problems for law enforcement since current presumptive test kits either 1) don't work at all or 2) work somewhat in differentiating between legal and illegal hemp crops. This problem exists because most hemp crops and hemp products contain low levels of THCA and THC. Our approach involves the development of an efficient, mobile, liquid-liquid extraction that provides presumptive (qualitative) forensic evidence of the chemical extract of a bud or other plant material. The evidence would later be sent to a crime lab for definitive analysis of tetrahydrocannabinol (THC) content, the psychoactive compound in marijuana. This research has focused on the utilization of liquid-liquid extraction techniques and commercially available stains. The methods presented are rapid (requiring no more than five to six minutes to complete). The differentiation between two lots of commercially available hemp and seven lots of marijuana obtained from the Cookeville City Police will be presented.

Undergraduate

*RESEARCH AND DEVELOPMENT OF HIGH PROTEIN BEER

Primary Author: Julia Vesely, Human Ecology

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Andrew Callender

Higher protein levels in beer can cause an undesirable taste and cloudiness to the finished beverage, as well as contribute to the stability of head, also known as foam. However, beer brewed with certain types of malts (such as sorghum) can increase the protein content in beer without the less desirable qualities. In addition, there are other protein-containing ingredients that can be added during various stages of the brewing process that may contribute to increasing the protein levels. Yet, the effects of these adjuncts on the drinkability of the final product is still unknown. With such a large push for foods and drinks that are elevated in protein in the current market, the development of a beer with higher-than-normal protein content would be desired and enjoyed by many. The main research questions for this project were (1) how much protein or how little protein can be added to be considered 'high protein?' (2) how much protein or how little protein

can be added before ruining taste and clarity? (3) what ingredients or adjuncts work the best? (4) how much does protein affect the Alcohol by Volume (ABV)?

Undergraduate

*SPECTROSCOPIC CHARACTERIZATION OF PHENOTHIAZINE CO-CRYSTALS

Primary Author: Wesley Wearing, Chemical Engineering

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborators: Lillian Pipkin; Oana Cojocaru, Dr. Cojocaru, TTU Department of Chemistry

Advisor(s): O. Andreea Cojocaru

Pharmaceuticals are commonly sold in the form of crystalline and amorphous solids as hydrates, solvates, salts, polymorphs, or co-crystals. The major disadvantage of the solid form is the existence of polymorphism, which can often occur due to changes in the crystalline structure of the compound. In the case of pharmaceuticals, this can greatly affect and reduce the efficacy of the drug. This issue can be avoided by converting the solid-state pharmaceuticals into a liquid form (i.e., ionic liquid or IL). Along with the elimination of polymorphism, liquid state drugs have several additional advantages over their crystalline counterparts such as they can potentially have an increased bioavailability and can add new administration methods (i.e., cutaneous delivery) while the component ions retain their pharmacological function (therefore adding the potential for dual functionality). Aliphatic-based phenothiazine drugs exist in solid state as crystalline hydrochloride salts. Due to the presence of basic nitrogen sites within their structures, these drugs can be converted into liquid form when paired with appropriate organic anions (such as carboxylates) potentially forming either fully ionized compounds or liquid co-crystals. This research focuses on the liquid co-crystal forming potential of several phenothiazine drugs when paired with carboxylate anions of varying hydrophobic character. Several compounds were synthesized via metathesis reaction and known spectroscopic techniques were used to determine the degree of ionization in the synthesized compounds.

Undergraduate

SOLAR DISTILLATION OF ESSENTIAL OILS FROM SPICES

Primary Author: Ashley Williams, Chemistry

Advisor(s): Dan Swartling

Our research is over solar distillation of essential oils from spices using a parabolic reflector. This distillation process can distill out desired chemical compounds used in the drug synthesis process in the pharmaceutical industry. The focus is on extracting oils from lemongrass and cloves and compare energy use from a lab distillation vs a solar energy distillation. The refractive indexes of the products will be used to compare purity of the chemical compounds extracted. Product yield will also be used to compare the effectiveness of solar distillation compared to lab distillation for future uses in industry. Results for optimizing reactions using solar energy are ongoing, and once more data is obtained the product yields and purity can be used to optimize the reactions.

Department of Earth Sciences

Undergraduate

*ANALYZING MUDSTONE GEOMETRIES WITH X-RAY DIFFRACTION IN THE MISSISSIPPIAN FORT PAYNE FORMATION, TENNESSEE

Primary Author: Austyn Allen, Geosciences

Co-Author(s)/Collaborators: Jeannette Wolak, Tennessee Technological University; Larry Knox, Tennessee Technological University

Advisor(s): Jeannette Wolak

The location of study was near Celina, Tennessee on Highway 52, specifically at latitude 36.53388889, longitude -85.49888889, and elevation 237 meters. The purpose was to collect samples of mudstones in Mississippian-aged channels, mounds, and drapes to see if there was a unique X-ray Diffraction (XRD) signature, which would imply different origins for the mud.

Two samples were collected from each channel, mound, and drape located in the Fort Payne Formation to be used in the analysis. The samples were left to dry from any water content present in the outcrop, finely ground using a ceramic mortar and pestle, and analyzed by X-ray Diffraction in bulk packs to determine the average bulk composition. The samples were analyzed with two techniques. The bulk packs were with the parameters flat 4.8 to 85 degrees. The glass slide samples, used to identify the clays, were created using 50 grams of a sample, mixed over an hour with 500 milliliters of deionized water, and calgon added for a dispersant. Once processed, the glass slides were run 4 times, under different conditions, within the parameters flat 3.8 to 55 degrees. The next step is comparing all of our analyzed samples to determine if any unique X-ray Diffraction signatures are present. Future applications of our work could focus on using X-ray Diffraction techniques on logging samples to identify if the mudstone is the same layer or layers that we have measured in the Fort Payne Formation outcrops.

Undergraduate

*ROCKING AND ROLLING DOWNHILL: BOULDER DISTRIBUTION PATTERNS ON A MARTIAN TERRACED FAN, XANTHE TERRA

Primary Author: Allison Bohanon, Geosciences

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Advisor(s): Jeannette Wolak

Terraced fans are a relatively rare subset of fan-shaped features on Mars that display radial, stepped topography and concave-up profiles. This study focuses on the Camichel Crater fan located in the Xanthe Terra region. Features common on terraced fans are boulders, large rocky detrital fragments visible in high-resolution images. Hypotheses for boulder origins include: (1) impact processes; (2) erosion of steep slopes; (3) preferential removal of finer-grained material through erosion; (4) transport via laminar debris flows; and/or (5) transport via turbulent flood events. The purpose of this project is to conduct high-resolution geologic mapping and test competing hypotheses by analyzing boulder distributions on the fan surface. High Resolution Imaging Science Experiment (HiRISE) images were used to evaluate small-scale features on the fan surface. HiRISE images have a resolution of 0.3 to 0.6 m/pixel; thus, boulders with a diameter of > 0.8 m were mapped in ArcGIS Pro at a scale of 1:3,400. Geologic mapping to identify depositional units was conducted at a scale of 1:4,000. Results show boulders

can be linked to erosional and depositional processes. Boulders mapped on the Camichel Crater fan are primarily associated with steep topographic scarps adjacent to feeder channel walls or terrace edges, likely a result of over-steepening and erosion. In distal fan units, however, high boulder distributions in the light-toned unit suggest flow competence and boulder transport during deposition. Future work will compare patterns to boulder distribution patterns in terrestrial fan settings such as alluvial fans and Gilbert-type deltas.

Undergraduate

*RECONSTRUCTING THE LATE MISSISSIPPIAN PALEOCLIMATE: STRATIGRAPHY AND XRD ANALYSIS OF THE PENNINGTON FORMATION, SPARTA, TENNESSEE

Primary Author: Jace Bolix, Geosciences

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborators: Dillon Preston; Riley Grecol; Lauren Michel; Wayne Leimer; Neil Tabor, Southern Methodist University

Advisor(s): Lauren Michel

The Late Mississippian represents a time when Earth was thought to be an icehouse and was experiencing eustatic sea level changes similar to today. While there's been a wealth of research done in the western equatorial Pangea for the Late Carboniferous and Permian, this study of the Pennington Formation, Tennessee, offers an opportunity to study less focused upon terrestrial early Carboniferous paleoenvironments from central equatorial Pangea, including the effects of diagenesis on paleoenvironmental proxies employed for paleosol research. New fieldwork of an outcrop outside Sparta, TN shows interbedded limestone and mudstone layers including four paleosol profiles that have been described and analyzed for their principle clay mineralogy. The paleosols preserve typical vertic features including slickensides, mukkara and wedge-shaped peds as well as low chroma color and are thus gleyed Vertisols. The gleyed nature of these paleosols is either the result of forming under waterlogged conditions seen today in soils forming proximal to shorelines or the result of diagenesis associated with sea level rising. The presence of Vertisols intercalated between limestones suggests a persistent influence of glacioeustacy in conjunction with highly seasonal climates during base-level lowstands and soil development which gave rise to pedoturbation and the characteristic suite of vertic morphologies seen in outcrop. Clay mineralogy dominated by illite and vermiculite suggests burial diagenesis. This contrasts sites from the upper Pennsylvanian which contain evidence for eustatic sea level change but are suggestive of more ever-wet conditions and recorded by the common occurrence of thick coal layers atop mineral-dominated paleosol profiles.

Undergraduate

STRIKE-SLIP FAULTING NEAR SPENCER, TENNESSEE

Primary Author: Alexsis Bowen, Geosciences

Advisor(s): Michael Harrison

Recent road construction along Tennessee State Route 111 south of Spencer, Tennessee exposed 150 meters of fresh outcrop of Pennsylvanian-age Sewanee Conglomerate. Here, the Sewanee Conglomerate is a 40-meter thick crossbedded conglomeratic quartz arenite that is pinkish- to yellowish-gray and yellowish-brown in color. The outcrops on the east and west side of the road contain numerous strike-slip and thrust faults associated with Alleghenian deformation and the formation of the Appalachian Mountains 320-280 million years ago. This study aims to understand how these structures relate to the regional tectonics of the Cumberland Plateau.

The orientation of the 48 strike-slip and 52 thrust faults from the outcrop on the east side of the road were measured in the field with a Brunton compass. If present, slickenlines were measured on the fault surface as well. Stereoplots show a northeast-southwest trend for the strike-slip faults; however, the thrust faults show no preferred orientation. Fault-damage zones of white friable cataclasite occur in proximity to closely spaced strike-slip faults. These zones may represent conjugate strike-slip faults in the hanging wall of the Cumberland Plateau overthrust.

Undergraduate

HIGH-RESOLUTION GEOLOGIC MAPPING OF THE ALTA DELTA, NORWAY: A POTENTIAL EARTH ANALOGUE TO TERRACED FAN-DELTAS ON MARS

Primary Author: Stephen Clements, Geosciences

Advisor(s): Peter Li

Terraced fans on Mars are an unusual type of fan-delta that as of yet has no Earth analogue. These fans are small (<10km diameter) and generally have a semicircular shape, with terraced steps instead of a smooth slope or single escarpment. They generally form where a valley has incised a crater, suggesting a river or stream flowing into a crater lake. In looking for an Earth analogue, we turn to areas that we believe may be more analogous to the ancient Martian environment: colder, and relatively dry. One area of particular interest is the Fennoscandian Shield, in the areas above the Arctic Circle. Here, we see many small, semicircular deltas emerging from fjords (which themselves resemble the valleys as they incise crater walls), some of which seem to potentially have terracing. Given that Mars has experienced at some point in its past a relatively rapid desiccation, we further believe that the isostatic rebound of the Fennoscandian Shield may reflect the changing fluid levels that would have occurred in the Martian crater lakes, and potentially give explanation to the terracing we see. Using the new ArcticDEM 2m digital elevation map, we conduct an analysis of the fan-delta in Alta, Norway, comparing it to the terraced fan associated with Subur Vallis in Xanthe Terra on Mars, which has previously been mapped to a 0.25m resolution using photogrammetry, with the data originating from the HiRISE camera aboard the Martian Reconnaissance Orbiter and Mars Orbital Laser Altimeter aboard the Mars Global Surveyor.

Undergraduate

EVALUATING THE EFFECTS OF LAND USAGE ON WATER QUALITY IN FALLING WATER RIVER WATERSHED IN COOKEVILLE, TN

Primary Author: Anna Foster, Geosciences

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Laura Moreno

Advisor(s): Joseph Asante

Water quality and land use are closely related and must be considered in city planning. Cookeville is one of the fastest growing micropolitan cities in the United States; therefore, the purpose of this study is to properly assess consequences of future land use change on the water resources of the Falling Water River watershed. In this study, the physico-chemical compositions of water in three sub watersheds of the Falling Water River are being determined in relation to their land use. The study area is a karst landscape and water is susceptible to contamination by human activities. The studied subwatersheds are: Taylors Creek, Cane Creek, and Falling Water River (upper and middle). Major land use was calculated for each subwatershed. Various parameters were measured at the field site. The major

ion concentrations were measured at the water center at Tennessee Tech University.

Data collected shows that in more urbanized areas, water is subject to excess levels of calcium and sodium. Areas where land use is a close percentage between agricultural and urbanized land, water is subject to have a larger range in dissolved major ions and also higher pH values. In more rural areas, there is a greater dispersion of chloride and calcium ions in the water. All sample sites were subject to an increase in calcium levels - to a varying degree. Areas with more urbanized land usage, the water tends to have lower pH values and smaller range in hardness and smaller coefficient variation of parameters.

Undergraduate

*WATERSHED COMPARISON OF THE EFFECTS OF LAND USE ON WATER QUALITY

Primary Author: Adam McLerran, Geosciences

Advisor(s): Evan Hart

A comparison of water quality was conducted during October 2019 on an agricultural watershed and a forested watershed, both located in northern middle Tennessee and a small portion of one in southern Kentucky. The Little Trace Creek watershed (HUC-12-051100020101) is approximately 25,426 acres and 61% agriculture, mostly cattle and poultry operations. The Jennings Creek watershed (HUC-12-051301060302) is approximately 36,075 acres and 84% forested. The land use data was collected from the Multi-Resolution Land Characteristics Consortium Website. Conductivity and dissolved oxygen were measured using a YSI® Professional Plus Multiparameter Meter on three separate occasions on three separate streams within each watershed. The data indicates a noticeable difference in water quality between these two watersheds. The dissolved oxygen measurements showed more variation in the agricultural watershed (SD of 2.2) than in the forested watershed (SD of 0.5). The forested watershed showed a higher average dissolved oxygen level at 7.61 mg/l than the agricultural watershed at 7.23 mg/l. The conductivity was also more variable for the agricultural watershed (SD of 14.1) than the forested watershed (SD of 7.4). The agricultural watershed had an overall average conductivity of 276.2 µs/cm as opposed to the forested watershed at 253.4 µs/cm. One stream in the agricultural watershed stream had a lower average dissolved oxygen at 5.21mg/l, which is close to the minimum value of 5.0 mg/l necessary for good water quality. Further research could determine the causation of the lower dissolved oxygen.

Undergraduate

*POTENTIAL PRESERVATION OF SKIN AND INTERVERTEBRAL DISCS IN A JUVENILE DINOSAUR (EDMONTOSAURUS)

Primary Author: Sierra Sesler, Geosciences

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborators: Larry Knox

Advisor(s): Larry Knox

Soft tissue preservation in dinosaur fossils is relatively rare although a few examples have been found (Davis, 2014). We recovered a juvenile hadrosaur from the Hell Creek Formation of Montana with both skin impressions and potential preservation of intervertebral disks. Thin sections across original skin impressions have a dark, apparently organic rich, carbonaceous layer where skin would have been present in the original animal. This strongly suggests that the soft tissue was mineralized and preserved. However, we were unable to optically image cell boundaries similar to those figured by Manning, et al, (2009) that might demonstrate the presence of mineral

cements that might outline the original cell boundaries. Apparently, the tissues in our hadrosaur were too decomposed to preserve such fine detail.
Thin sections of the disks that occur between vertebrae are composed of fine-grained sandstone, which filled in the spaces between the vertebrae. Although this is a process that is not completely understood, it is clear that the skeleton lacks the presence of mineralized cartilage. The dark colored spots in the disks may, however, represent bits of cartilage material that has largely decomposed into carbonaceous material.

Of the three types of preservation of dinosaurs suggested by Schweitzer (2012) our specimens has definite preserved impressions, possible compressions, but so far we have been unable to demonstrate preservation of three dimensional permineralized tissue.

Department of English

Graduate

*MACHIAVELLIAN MISCHIEF: GENDER DISTINCTIONS BETWEEN MACHIAVELS IN HEYWOOD'S THE SECOND PART OF KING EDWARD IV

Primary Author: Samia Anderson, English (M.A.)

Advisor(s): Kristen Deiter

In Thomas Heywood's drama, The Second Part of King Edward IV, the pages include a wide range of characters who exude Machiavellian characteristics. Most notably, the male characters in Heywood's drama, such as Richard III and Dr. Shaw fit the standard definition of "Machiavellian" almost perfectly. Each of these men are distinctly Machiavellian in that they are schemers who typically prefer convenience over morality, and they commit many evil deeds which they never repent for. These lawless actions propel them to or keep them in power, making them Machiavellian. On the other hand, women such as Jane Shore, Queen Elizabeth, and Mistress Blage may also be viewed as Machiavellian as their sins are also for their own gain, but so are their acts of kindness. While the men typically execute feigned acts of kindness to further their own gain or access to power, the women perform genuinely good deeds for the same purpose. Thus, the women aid in displaying that not all Machiavellian characters are completely without morality. While Machiavelli makes clear in The Prince that characters must be evil or feign kindness in order to gain or keep power, I believe that does not necessarily reign completely true. I analyze the parallels between male and female characters in The Second Part of King Edward IV to argue that the women, while somewhat Machiavellian in their traits and tendencies, are not complete Machiavels like their male counterparts but still further their personal goals of power through their Machiavellian characteristics.

Graduate

*RICHARD III'S BESTIAL MASCULINITY AND THE RHETORIC OF ANIMALITY IN THOMAS MORE'S HISTORY OF RICHARD III AND THE TRUE TRAGEDIE OF RICHARD THE THIRD

Primary Author: Lauren Morgan, English (M.A.)

Advisor(s): Kristen Deiter

Through a feminist lens, this essay reveals the fragility of masculinity through an analysis of the ways in which Richard III is typified by animalistic imagery and rhetoric as a monstrous figure; his unruly, violent tendencies critique the instabilities inherent within a society that is

structurally dependent on masculine values and aggression. Due to more recent scholarship by feminist and queer theorists, the study of gender tends to shift its focus on the marginalized by allocating agency to those excluded from the historically privileged category of male elites. Rather than analyzing those outside the center, I focus within the structure by exposing incongruities that existed within performances of masculinity in early modern patriarchy. Taking More's History of King Richard III and The True Tragedie of Richard the Third as my points of departure, I argue that both characterizations of Richard III function as passionate denunciations of lawless masculinity by emphasizing his perverse destruction of "effeminate character" or feminine allegiance through a discourse of animality. I focus on the animalistic rhetoric and imagery surrounding Richard III's birth, his heraldic emblem, and his death to strengthen my argument. This paper was written for my Topics in British Literature to 1667: Sixteenth-century English Literature class during Fall 2019.

Graduate

JANE SHORE: MACHIAVELLIAN MASTERMIND

Primary Author: Carrie Rozar, English (M.A.)

Advisor(s): Kristen Deiter

Thomas Heywood's Jane Shore, in the Second Part of King Edward IV, proves to be a complex character who faces the moral struggle of accepting the king's advances and propositions. While it may seem like her character is shown to be meek and kind, she uses her influence and power as the king's mistress to give pardons to those who have been wrongfully punished, as well as further her own ends of power. While it seems that she struggles with her moral dilemma in using her adultery for the greater good, Jane subsequently faces the fallout from everyone finding out about the affair and must do whatever she can to save herself in the process. Jane seemingly struggles not only with her guilt in breaking her husband's heart but also in having to face the Queen once she has been informed of the affair. In this essay, I explore Heywood's depiction of Jane and argue that she functions as a Machiavellian character because she uses her position as the king's mistress to further her own ends, even if they are perceived as noble, through pardoning people that she views as wrongfully accused of treason or other various crimes and manipulating those around her, as they discover the affair, to view her as a kind and pious woman, despite her garnering and consolidating her own access to power through the affair with the king.

Undergraduate

*MAKING THE WAY TO MARRIAGE: LANGUAGE AND LOVE IN SHAKESPEARE'S PLAYS

Primary Author: Rebecca Franey, English

Advisor(s): Kristen Deiter

The language in William Shakespeare's Romeo and Juliet and Much Ado About Nothing turns love into a game through opposing sentiments of adoration and cynicism between Romeo and Juliet and Beatrice and Benedick, while differing dictions show adverse interpretations of Elizabethan age courtship practices. This paper takes a deeper look into the plays' language, especially the style and vocabulary of each character, to trace the success and failure of each relationship.

Romeo and Juliet exemplify youthfulness and urgency while racing through societal practices, catering to their need for marriage by omitting courtship steps that are integral to communal acceptance. The focus is only on their love, shown through flowery poetry with exaggerated metaphors.

Beatrice and Benedick present a contrasting attitude with cynicism that precedes secret vows, which are prompted by emotions exposed by their family and friends. Community

approval permits the couple to pursue their love with less hesitation and openly commit to a courtship, but they continue to use word games that express their complicated relationship.

In each play, urgency, maturity, love, and loathing contribute to an engagement, but community involvement plays the largest role in determining the success or failure of the marriage. Each couple employs various literary devices in their language to add new interpretations of words while progressing through the stages of courtship, showing their love in contrasting ways.
I wrote this paper for my Shakespeare class.

Undergraduate

*VICTIMS OF GENDER POLITICS: A COMPARISON OF JANE SHORE IN THE SECOND PART OF KING EDWARD IV AND MARGARET THATCHER

Primary Author: Abbigail Jackson, English

Advisor(s): Kristen Deiter

When thinking of powerful women in Medieval and Early Modern England, one normally does not think of the literary character Jane Shore. I argue that the Jane Shore portrayed in The Second Part of King Edward IV is not only a powerful woman, but also a political figure. I point to examples of Shore using her influence over King Edward IV to make political moves and acting on her own accord. That is, she does not rely on a man to give her agency. I compare her to former Prime Minister Margaret Thatcher to show that the treatment of women in politics did not change much in the intervening 500 years. I chose Margaret Thatcher to bring in a modern example of a woman in British politics, and to compare and contrast how the two women functioned in politics. While Heywood's Jane Shore and Margaret Thatcher were from completely different times, had different roles in society, and held different positions of power, they were both victims of gender politics. Both women went against gendered expectations by demanding autonomy, making their own decisions, and joining the world of politics, and both women suffered the consequences of these actions.

Undergraduate

*A MORAL INTERPRETATION OF WILLIAM SHAKESPEARE'S ROMEO AND JULIET

Primary Author: Kitty Porterfield, Communication

Advisor(s): Kristen Deiter

Though William Shakespeare's Romeo and Juliet is most often read as a tragic love story, the setting in which it takes place, as well as the ideals of people in Elizabethan England, support a moral-focused reading of the play, rather than a fateful or romantic reading. The impassioned, reckless actions of the star crossed lovers and the lack of guidance in their trusted mentor, Friar Laurence, combine to form a tale of caution, warning Elizabethan audience members of what happens when faith and logic are set aside and impulse and emotion take over. The possibility of Romeo and Juliet being a warning to readers and audience members rather than a romance is reinforced by the explicitly sinful thoughts and actions of the characters, who knowingly and continually go against their Catholic faith, ultimately resulting in their deaths. Shakespeare's iconic love story is, in actuality, saturated with moral reproach toward the actions of the adolescent, impressionable lovers and their misguided but well-meaning advisor and priest, whose naivety led to the demise of young Romeo and Juliet.

Key words: Romeo, Juliet, Friar Laurence, Catholicism, Morality.

Department of Foreign Languages

Undergraduate

*THE EFFECTS OF SOVIET OCCUPATION ON EAST GERMAN CHILDREN'S LITERATURE

Primary Author: Allison Adams, Foreign Languages

Advisor(s): Julia Gruber

The Soviet occupation of East Germany during the Cold War affected East German children's literature. There were a variety of rules placed on the types of books that were allowed to be published and read by children. During the beginning, many authors strongly adhered to these rules and many children's books were simply translations from the Soviet Union. However, as time passed East German children's authors gradually evolved to writing more complex stories that better reflected children's life in East Germany, as well as integrating various social criticisms better geared for adults. Because of the censorship enacted under Soviet occupation, children's literature became an important vehicle in portraying criticisms of the Soviet occupation in East Germany.

Undergraduate

FROM CHILDREN'S PICTURE BOOK TO SOCIAL EXPRESSION AND PROPAGANDA

Primary Author: Harrison Eldridge, Computer Science

Advisor(s): Julia Gruber

"Der StruwwelPeter" or "Shock-headed Peter" by , a German children's book written in 1845 is one of the first children's books written and is still popular to this day. The book's popularity quickly spread across Europe and America. Many adapted it into their own language, including American novelist Mark Twain writing his version as "Slovenly Peter". However, with its popularity came parodies and different versions of the book with people's own twists. For examples: During World War II, a British authors Robert and Philip Spence wrote "StruwwelHitler", a parody published and sold as relief effort for victims of Nazi bombings. "Der Anti-StruwwelPeter", written by F.K. Waechter, turns the message of "Der StruwwelPeter" and its head and inverts the role of parents and children taught in the original.

This project collects those other versions, parodies, and translation across the time since its publication to analyze, compare, and contrast how different cultures and people interpret and react to Hoffmann's "Der StruwwelPeter" in different periods of time in different social and political environments.

Undergraduate

*THE HOLIDAY FOR WITCHES IN MARCH, "HEXENNACHT"

Primary Author: BreeAnna Finch, International Business and Cultures

Advisor(s): Julia Gruber

People all over the world celebrate multiple times a year. While many dates, or even events, differ among locations, there are also location-specific holidays. A holiday that people in the United States might not be familiar with is the German holiday, "Hexennacht". It is a culturally diverse way with which people mark the changing of winter into spring. Learning something such as a holiday specific to a certain culture can be a helpful way to understand cultures better and may facilitate connecting with more people. This poster will include research and information to help describe and explain the historical and cultural significance of the holiday, "Hexennacht", which takes place on April 30th, while also explaining how this day is celebrated. The information presented on my poster will explain the origin of the holiday, where it is celebrated, and the evolution of how it has been celebrated since it's beginning

Undergraduate

THE USE OF HORROR IN CHILDREN'S LITERATURE AS A MEANS TO TEACH LESSONS OF RIGHT AND WRONG

Primary Author: Jessica Hunt, English

Advisor(s): Julia Gruber

Imagine you are reading a story to your child before bed and that story happens to be about all the gruesome ways naughty children can be punished for not listening to their parents— or perhaps your child is learning their ABC's and each of the 26 letters represents a child that has somehow died a horrible death. These are the plots of the vividly imaginative and highly controversial children's books, Der Struwwelpeter by Heinrich Hoffman, and The Gashlycrumb Tinies by Edward Gorey. Because of their grisly demeanor, many critics argued that these stories were not meant for children at all. Despite these allegations, these authors had no ill intentions of frightening or mentally scarring children with their stories. These stories were, and still are, used as cautionary tales with the purpose to entertain children with their use of whimsical illustrations and sing-song, rhyming lines that create an overall message that a child can learn from after reading the tale. The purpose of this project is to highlight the methods used by these authors to show how the grotesque horror used in their stories was not meant to maim the minds of children, but was rather a method to amuse them while teaching them lessons like right and wrong and life and death.

Undergraduate

*BURN THE WITCH! WITCHBURNING AND DER STRUWWELPETER

Primary Author: Thomas Loyd, English

Advisor(s): Julia Gruber

One particular children's tale in Struwwelpeter, "Die gar traurige Geschichte mit dem Feuerzeug" ("The Very Sad Story with the Lighter"), in which a small girl plays with fire and burns to death, has some noticeable allusions to witchcraft and how it was dealt with in the past. This presentation will draw connections between this children's story written in the 1840s and real-life witch trials that took place in Germany and other places around the world, and also works of fiction that share some similar themes with it.

Germany was host to a few witch trials in the past, though definitely not as many as some other European countries. These were still very deadly, with many of the victims being burned to death. As for the fictional contexts, there are examples from more classical works to ones from more recent years that go hand in hand with "Die gar traurige Geschichte mit dem Feuerzeug" in several ways.

Could these real-life events and works of fiction have had some hand in inspiring the author of Der Struwwelpeter, Heinrich Hoffmann, to pen this children's tale? Is it possible that this particular story in Der Struwwelpeter is a callback to the witch trials and burnings of centuries passed? We will dig into the historical and literary contexts surrounding this macabre story and find out.

Undergraduate

*THE STORIES OF HUMOR AND HORROR: DER STRUWWELPETER THROUGH MULTIPLE CULTURES

Primary Author: Ryan Moyers, English

Advisor(s): Julia Gruber

Der Struwwelpeter, a collection of German Children's Tales from the 19th Century, written by Dr. Heinrich Hoffmann, warns children about what will happen if they disobey their

parents or do something foolish and dangerous. Hoffman's instructive and morality-centered stories, coupled with sometimes silly and colorful images alongside, shock many today with the rather gruesome endings for the characters, mainly children. People in the German-speaking world, who grew up with these stories, laugh and enjoy the book for its silly illustrations and wild events. Some buy it for their children, others would never read it to their offspring.

This project will analyze how different cultures view the imagery and lessons contained within Der Struwwelpeter and how they still today are enjoyed by many and why others reject the book.

When the book was first published in the 1840s, parents disciplined their children very differently; children were expected to be quiet and obedient. They were not the center of their parents' universe like today. Many parents today would not agree with showing their child a book that depicts children's deaths or serious injury, even if it was to teach them a lesson. Despite this distinct difference in teachings for children, Hoffman did do some good. The project will touch on how his book changed a genre, or perhaps created one as we know it today, while also acknowledging that most would not use these methods to teach their children any longer.

Undergraduate

*STRUWWELPETER'S USE OF IMAGERY TO SUBVERT GERMANY'S IDEA OF PROPER PEDAGOGY

Primary Author: Xavier Schlueter, English

Advisor(s): Julia Gruber

Struwwelpeter was the first children's books published in Germany. Its use of cartoonish imagery and gruesome punishments enacted on children resulted in discussions about how moral pedagogy was to be taught to children. Struwwelpeter utilizes the construct of black pedagogy, which is the use of repressive and harmful tactics to enforce authority in children, to subvert the idea of proper pedagogy. The popular assertion during the publication of Struwwelpeter, was that proper pedagogy could only be constructed in the minds of youth through accurate depictions of reality. Struwwelpeter subverts this notion by using a less professional art form, as well as, taking the concept of black pedagogy to undermine the ideas of popular authority. This paper proposes that the use of black pedagogy in Struwwelpeter, ironically, undermines this authority, which it traditionally supports.

Undergraduate

*LOCAL CUISINE IN GERMANY

Primary Author: Prinya Tep, Foreign Languages

Advisor(s): Julia Gruber

Food can teach you a lot about a culture. What people eat reveals a lot about the things within their surroundings. For example, while France is known for its cheese, Germany has always been famous for its sausages, bread and beer.

My project will delve into unique German dishes that can be found throughout the country and examine why certain foods are consumed in their respective regions. I will look into the reasoning behind the popularity of the foods despite their, occasional, unsavory appearances. At the same time, I will look into the beverages served throughout Germany. The stereotypical beverage is beer but the country also produces wines and is particular about its coffees. In addition, to the foods and beverages, a few of the regions are also able to boast about their chocolates which is another interesting topic to look into. I will also look at the different ways Germans refer to the same food. Finally, I will highlight food that was brought to Germany by immigrants and became an everyday meal for Germans, such as Döner.

Undergraduate

*DER STUWWELPETER AND THE ENTERTAINMENT INDUSTRY'S PROMOTION OF VIOLENCE IN MEDIA FOR CHILDREN

Primary Author: Lyndsey Wall, Biology

Advisor(s): Julia Gruber

Der Stuwwelpeter is a renowned German children's book. It is both known for the stories it contains as well as the illustrations. When seeing this book, generally people are appalled by the horrible things that happen to the children who misbehave, but when taking a look at our own modern form of children's entertainment, one should ask: Is the violence all that different?

The comparison of Der Stuwwelpeter to other books of the 19th or 20th century have often been made and have been described as common for the time, but in reality, violence is put in many unexpected places. Children are often exposed to violence, e.g. when they watch cartoons, play video games, read books, or experience it themselves in their homes. My poster will compare violence in entertainment for children and bring to light the actual commonality this violence has with Der Stuwwelpeter.

Undergraduate

*TRANSFORMATIONS OF FAIRY TALES FROM THE ITALIAN ORIGINAL TO VERSIONS BY THE BROTHERS GRIMM AND WALT DISNEY

Primary Author: Rose Webb, Foreign Languages

Advisor(s): Julia Gruber

My topic encompasses fairy tales and princesses, beauties and beasts across the Atlantic and across time. Fairy tales and how they transformed from original tales to today's modernized versions.

There are many princess characters Walt Disney appropriated for the US film industry; Rapunzel, Cinderella, Beauty and the Beast, Sleeping Beauty and Snow White. All have their origins with the Brothers Grimm's Fairy Tales collection. Disney toned down the blood and cruelty from the Grimms' versions. My poster will focus on the depiction of Sleeping Beauty, which was first released as the classic Disney film in 1959. There have been six more film versions released since then. The Grimms had collected their tale from the Italian poet Giambattista Basile in 1634. The Grimms and Walt Disney's Sleeping Beauty were very similar. The Italian original version was vastly different. My project will show changes the story underwent.

Department of History

Undergraduate

*RESISTANCE IN THE WARSAW GHETTO UPRISING

Primary Author: Thomas Hudson, History (B.A.)

Advisor(s): Elizabeth Propes

In my research project, I aim to show the challenges Jewish fighters faced during the Warsaw Ghetto uprising. My research will highlight the actions perpetrated by the Nazis that motivated some Jews to resist them. It will also highlight the initial lack of resources and support from people outside the ghetto and from other residents as neither groups believed the resistance stood a chance. From there, it will follow the efforts by the resistance to gather weapons and other resources to resist the Nazis, such as purchasing weapons from the black market or resistance groups outside the ghetto. Eventually, I will cover the initial battles between the resistance and the Nazis and how well they held out. Along with the battle, I will also draw attention to how noncombatants in the ghetto reacted and how some tried to escape. In the conclusion of the research, I will show the actions the Nazis took to eventually crush the resistance, though small groups of Jewish fighters held out.

Undergraduate

*DISCRIMINATION OF AFRICAN-AMERICAN SOLDIERS DURING WORLD WAR II

Primary Author: Jennifer Viles, History (B.S.)

Advisor(s): Elizabeth Propes

African-Americans in the military during World War II experienced high levels of discrimination, even though they wore the same uniform as white soldiers. Many African-Americans felt that they were fighting two wars: the war against foreign enemies and the war against discrimination. African-Americans made efforts to prove themselves to their fellow white soldiers. Officer training was denied to many African-American soldiers even though many passed the test to enter the training program. While black and white men went through the same training, many African-Americans received commissions in labor units instead of fighting units. In other cases, the military allowed more specialized training, such as the Tuskegee Airmen. African-Americans also experienced discrimination when interacting with other countries, such as Australia, France, and Britain, which enacted laws specifically to prevent black American soldiers from interacting with their citizens. All nations failed to recognize black Americans for their service, and in the U.S., African-American soldiers did not receive the Medal of Honor when their white counterparts did. The discrimination experienced by African-American soldiers connected with other issues that were at the center of the Civil Rights Movement. While the U.S. military desegregated in 1948, it was not until after the Civil Rights Movement that African-Americans began receiving recognition for their service.

Undergraduate

*HISTORICAL AND SOCIOLOGICAL IMPACTS OF THE DUCK RIVER ON MAURY COUNTY, TENNESSEE COMMUNITIES

Primary Author: Mikayla Wood, Environmental and Sustainability Studies

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Megan Atkinson

Global communities and cultures have been greatly shaped because of river systems. Rivers often shape several aspects of a community, some of which include settling patterns and industry. The Duck River has been shaping the lives of those living in Maury County for centuries. I conducted my research by examining how the Duck River has impacted three groups of people in Maury County. I examined the Duck River's sociological and historical impact on Native Americans, early European settlers, and modern day Maury Countians.

I found that Native Americans who lived in the Maury County area prior to European settlement used the Duck River for fishing. The Duck River was highly respected by the indigenous population living in the area. Early Europeans in Maury County settled near the Duck River so they could take advantage of the Duck River's resources. Early European settlers built dams, mills, and shops along the Duck River. The Duck River was also used as a way to transport materials and goods. Today, the Duck River is the water source for those living in Maury County. The Duck River is also used for recreational purposes like canoeing and kayaking.

Department of Mathematics

Undergraduate

*A LONGITUDINAL STUDY OF CRITICAL ASSET FAILURES: STATISTICAL MODELS AND INFERENCE

Primary Author: Brelyn Grant, Mathematics (M.S.)

Advisor(s): Motoya Machida

Having the ability to assess risk to plan capital investments for critical assets has major financial, scheduling, and reliability implications for electric utilities. This study aims to develop methodology to examine the nature and factors of failure for critical assets at a North American electric utility. We apply accelerated failure time (AFT) regression models using relevant data for major components of hydroelectric generators. The goal of this research is to produce survival curves and hazard curves, along with Wald confidence intervals, by using relevant asset nameplate data (such as megawatt rating, year installed, and manufacturer) and historical failure data. In order to accomplish this end-goal, we also develop a standard procedure of variable selection. The approach we take considers the fully parametric (scale, shape) Weibull distribution with scale depending on covariates. From here, we employ maximum likelihood large-sample theory to produce Wald confidence intervals for the survival function and hazard function. We also utilize the “survival” package in the R programming language. Using this package, we develop code to visualize the associated curves for failure data. The final model with certain selection of covariates are reasonable, which allows us to produce the associated hazard curve and Wald confidence intervals adjusted for the effect of covariate value.

Department of Physics

Undergraduate

*CONTROL IMPROVEMENTS ON THE UCNTAU MAGNETIC MAPPER

Primary Author: Ryan Colon, Electrical Engineering

Advisor(s): Adam Holley

The UCNtau experiment utilizes a 670-liter magnetic array designed for the purpose of trapping ultracold neutrons (UCN) with minimal sources of loss. The array uses over 5000 NdFeB magnets to achieve this purpose. Understanding the magnetic field generated by these magnets is key to the experiment, and so it is necessary to have a practical method of mapping the magnetic fields in the trap. This information is useful for ensuring the magnetic field is large enough everywhere to prevent UCNs from escaping and provides empirical inputs into spin dynamics simulations of the experiment. To efficiently collect the magnetic field information, a magnetic field mapping robotic arm was manufactured and implemented, and the efficiency of the arm continues to be improved upon. Control code was improved to allow for the automatic handling of critical errors during mapping runs. Specifically, code allowing for the arm to try and re-find a missed surface point and skip points that it fails to find was implemented; Additionally, code that allows the arm to continue an aborted mapping run with minimal user input after critical errors was developed. The control code additions and their effects on the running of the arm, as well as future control code improvements will be presented.

Undergraduate

*DEVELOPMENT OF A SCMOS POSITION-SENSITIVE UCN DETECTOR

Primary Author: Darsh Dinger, Physics

Advisor(s): Adam Holley

Position-Sensitive Detection (PSD) of particles on a two-dimensional detection plane can be useful in experiments that require characterization of free-moving particles. PSD can aid in the study of systematic effects such as depolarization and phase space evolution in trapping experiments such as the ultracold neutron (UCN) free neutron lifetime experiment UCNτ. PSD is demonstrated using a relatively inexpensive “scientific” complementary-symmetry metal-oxide-semiconductor (sCMOS) camera from PCO to image an Ag enriched ZnS scintillator coated in 10Boron from a distance of 1.2 meters away. This scintillator was excited using an 241Am source which emits alpha particles at 5.48 MeV. The optical design of this PSD system will be discussed, along with details of signal characterization.

Undergraduate

*MOTOR CONTROLLER FOR THE 98 RUBIDIUM DECAY SPECTROSCOPY STATION

Primary Author: Sean Jones, Electrical Engineering

Advisor(s): Mustafa Rajabali

The investigation of the structure of the 98Rb and 98Sr isotopes have gained considerable intrigue due to their diversity in nuclear shapes around similar energy levels. To properly investigate these isotope structures we must be able to accurately measure and identify the spin of the isomeric states using a decay spectroscopy station. However, we must be able to isolate the short lived decay states of 98Rb from the longer living daughter decays such as 97Zr and 97Nb. In order to prevent measurement of the longer living daughter decays on the tagging scintillators,

the 98Rb beam will be implanted on an aluminum wheel where the short lived decays can be measured. The wheel will then rotate behind a thick steel barrier to help shield the tagging scintillators from the daughter decays. The aluminium wheel will need to be controlled precisely and be able to rotate rapidly as the half life for 98Rb is only 114 ms. For this we will use the AZM46MK stepper motor and AZD-KEP motor controller. Housing for the motor controller will need to be constructed to properly power the controller as well as retrieve the signals sent from the decay station and relay them to the controller. It is essential the stepper motor is controlled properly and accurately to insure the best results for the experiment.

Undergraduate

*COMPARING THE PERIOD-LUMINOSITY RELATIONSHIP TO DISTANCE FOR THE RR LYRAE STAR EZ LYR

Primary Author: Kaitlyn Kidwell, Physics

Co-Author(s)/Collaborators: Alya Sharbaugh; Michael Fitzgerald, Our Solar Siblings; Mary Kidd, Tennessee Tech University

Advisor(s): Mary Kidd

RR Lyrae stars are periodic variable stars often used as standard candles to measure intergalactic distances. Our group calculated the period-luminosity and distance-luminosity relationships for RR Lyrae star EZ Lyr for comparison with previously established results from the GAIA satellite. In collaboration with the Our Solar Siblings program, we requested images of EZ Lyr from the Las Cumbres Observatory's (LCO) 0.4 meter SBIG telescopes on a set cadence until adequate data was acquired. EZ Lyr's luminosity was determined by analyzing subsequent light curves from the LCO images. Using this observed luminosity in the relationship described in Caceres & Catelan 2008, distance was calculated. For the star EZ Lyr, the PL distance was consistent with GAIA observations.

Undergraduate

*BETA-DECAY SPECTROSCOPY OF 96-99KR

Primary Author: Aaron Kindred, Physics

Advisor(s): Mustafa Rajabali

Nuclear structure studies reveal the coexistence of many different shapes of the atomic nuclei. An interesting set of nuclei to study are found around neutron number N = 60, where a preferred oblate (disk shaped) nuclear structure of the neutron-rich Kr isobaric chain is interrupted and intruded by the deformation of Rb, Sr, Y, and Zr. Here a sharp transition is observed from oblate (disk shaped) to prolate (football shaped). Studying the beta-decay of Kr through gamma-ray spectroscopy at the Isotope Separator and Accelerator facility at TRIUMF will provide a deeper understanding of the nuclear structure of the Kr isobaric chain at A = 96, 97, 98, 99. This data was obtained during a discretionary beam time for the development of neutron-rich Kr beams while using the GRIFFIN array alongside 11 beta particle scintillators. Work done towards the data analysis of this data set will be described in this poster.

Undergraduate

*LOW ENERGY BOUND STATES, RESONANCES, AND SCATTERING OF LIGHT IONS

Primary Author: Benjamin Luna, Physics

Co-Author(s)/Collaborators: Thomas Papenbrock, Joint Institute for Nuclear Physics and Applications

Advisor(s): Mustafa Rajabali

This work from the summer of 2019 represents theoretical calculations in pursuit of a low-energy model of charged

halo nuclei. Halo nuclei are nuclei with exhibit some neutrons or protons extending further out from the central core nucleus. The elastic scattering of light ions as well as energy resonances observed and the bound states of these ions will be described on the basis of a point-like potential describing the nucleus; a δ-shell potential. Focusing on low-energy data from previously conducted experiments and other data particularly from astrophysics, we adjust two parameters of the potential to some of these experimental observations and make predictions for other nuclear systems that will be described in this poster.

Undergraduate

*THE TTU PENNING ION SOURCE

Primary Author: Austin Marler, Mechanical Engineering

Advisor(s): Mustafa Rajabali

Ion sources are required for a variety of lab experiments we use in our modern world. Machines performing micro manufacturing, mass spectroscopy(measuring how much of what atoms you have in a sample) and particle science all require an ion source to begin their work. These sources can be created by a variety of means such as high temperature, chemical, electric, photo-voltaic and other methods. Different applications demand specific ion currents and energies which gives rise to the many methods of ion generation. Concerns of manufacturing cost, design time, and operation costs are heavily investigated for each ion source designed and our case is no different. This paper will describe the design process of the ion source to be developed for the TTU ion beam laboratory.

Undergraduate

*VISUALIZING THE MORPHOLOGY OF SOLAR FLARES IN THE AIA 131A CHANNEL

Primary Author: Alya Sharbaugh, Physics

Advisor(s): Mary Kidd

This project represents a small part of the general study by NASA's Marshall Space Flight Center into how the cameras aboard sounding rockets can be optimized for capturing the evolution of high temperature plasma in the Sun. Data for this analysis was provided by the Solar Dynamics Observatory (SDO), a NASA satellite launched in 2011 as part of the Living With a Star initiative. The SDO carries an instrument called the Atmospheric Imaging Assembly (AIA) which uses Fe V, XX, and XXIII to focus on flaring regions of the Sun. This presentation will detail the process of filtering usable satellite data using SunPy, modeling different parameters of solar flares, and mapping images of flares to create movies.

Undergraduate

*OPTIMIZING A PYTHON-BASED NEUTRON SPIN DYNAMICS SIMULATION CODE

Primary Author: Christian Swindell, Computer Science

Co-Author(s)/Collaborators: Adam Holley, Tennessee Technological University

Advisor(s): Adam Holley

The UCNτ experiment finds the mean lifetime of an ultracold neutron (UCN) trapped within a magnetic field before it undergoes beta-decay. One piece of information that helps determine this mean lifetime to a high precision is a neutron's depolarization lifetime (the average time from when any given UCN enters the field polarized until exiting via depolarization). One simulation we are currently developing attempts to determine this value by calibrating against trap lifetimes measured at different holding fields, which requires large amounts of mathematical computation. On a 10-core computer running Linux OS (at 1 neutron per core simultaneously), this currently takes about 36 hours to complete when simulating 100 neutrons. Realistically, we would want to run around 1,000,000

neutrons in a simulation to reduce our margin of error; however, that would take over 40 years to complete on the same hardware when scaled up. To reduce the amount of time it takes to run a simulation, optimization of the simulation code is required. To fulfill this requirement, this simulation code (originally written in Python) was benchmarked and optimized before conversion of part, and potentially all, of the code to C++. The methodology followed and what was found to be good practices for code optimization in general throughout this process will be presented.

Department of Sociology and Political Science

Undergraduate

DIVIDE AND BE CONQUERED

Primary Author: Davis Hendricks, Political Science

Advisor(s): Ronald McGauvran

Polarization, or ideological separation between political parties, and a parallel for support of authoritarian candidates has gained attention amongst political scientist. Some argue in support of polarization as a constant threat to democracy, other researchers have noted that the increasing support of authoritarian values is what may indeed pose a threat. This study seeks to answer the question: if it is the polarization of the public that leads to authoritarianism? Using American National Election Survey responses for the years 1980-2016 and examining trends in sub-regional polarization, I find that individuals who identify with their preferred party will have stronger authoritarian feelings. The different measures provided support the hypothesis in a gradual sense and the results significant. Even when accounting for factors that could affect both polarization and authoritarianism, substantial increases still occur. This research demonstrates that individuals do not understand the foundation of the opposition position by posing a relationship between increasing political polarization producing an increase in support for candidates with authoritarian tendencies.

Creative Media Inquiry Projects Developed by Students in the SOC 1650 Social Problems Course (Project Advisor: Ada Haynes)

Undergraduate

ADOLESCENT DEPRESSION AND THE EFFECTS OF THE MENTAL ILLNESS ON ADULTHOOD

Primary Author: Arrianna Littlefield, Psychology

Adolescent depression is a growing issue in America, putting these young adults at high risk for multiple negative issues when they reach adulthood. The majority of adolescents with depression are unable to seek help or lack the resources to receive help. Thus, they are unable to learn how to cope with the mental illness to overcome it. Depression in adolescents has been linked to criminal behavior, substance abuse, domestic/child abuse, alcoholism, suicide, unemployment, interpersonal difficulties, and additional mental issues when these adolescents reach adulthood. This not only directly impacts the struggling individuals, but also impacts society as a whole, as the mental illness affects rates of unemployment, poverty, crime, abuse, substance abuse, and suicide. The purpose for this project was to spread awareness and create change by explaining the seriousness of the issue at hand and offering a strategy to help these troubled adolescents. The strategy proposed in this project is getting the education systems involved. This can be made possible by

hiring a school psychologist, as well as having mandatory faculty training to go over signs and symptoms of possible children and adolescents at-risk. The educational system would become a safe haven for children and adolescents, rather than another stressful environment, by offering these children strategies to cope with and understand the mental illness, as well as offering relief and a support system they may not have elsewhere.

Undergraduate

FOOD INSECURITY AMONG CHILDREN

Primary Author: Kelsey Miller, Interdisciplinary Studies

Food insecurity affects a large number of children around the United States and the world. Food insecurity presents many challenges to those who are food insecure, and it is an issue that can be difficult to solve. This project presents research about the effects of food insecurity on children. This media project is an awareness campaign that brings to light a major social issue that is under recognized. In addition, it presents possible solutions to solving the problem and compares the impact of solutions that have previously been implemented. It also presents ways for people to get involved and volunteer if they are passionate about wanting to make a change. The hope of the video is to bring awareness to food insecurity among children and be a resource to those who may be struggling with this issue themselves. It gives food insecure individuals resources where they can seek help. It also gives some hope that there are ways to work toward solving this major social issue and we can one day have a world where no child has to go hungry.

Undergraduate

DOMESTIC VIOLENCE AGAINST WOMEN

Primary Author: Jamellia Potts, Psychology

Over the years, domestic violence against women has been a major problem. Women experience different forms of violence, which can be physical, emotional, and/or sexual violence from intimate partners or non-intimate partners. The purpose of this research project is to bring awareness to the people of Tennessee about the effects of domestic violence against women and show how the public can help reduce to amount of domestic abuse taking place around them. Through a sociological perspective people can better understand many current issues and create ways to help reduce these issues. To have a better understanding of domestic violence against women, conflict and feminist perspectives were used. A short video presentation was prepared to propose the best strategy to bring awareness to the people of Tennessee about the effects of domestic violence against women and show how the public can help reduce to amount of domestic abuse taking place around them. Through this video, the public will be able to know the signs of domestic violence, who to call if someone is a victim or knows a victim, and what actions to take. It also seeks to earn victims' trust so they can seek help.

College of Education

Department of Counseling and Psychology

Undergraduate

*THE MOTIVATIONAL FUNCTION OF INTERPERSONAL COMPETITIVENESS

Primary Author: Rebecca Hart, Psychology

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborators: Tess Simpson; Nicole Henniger, Tennessee Tech University

Advisor(s): Nicole Henniger

Competitiveness can bring out the best and worst in people. Competitive individuals has been found to be more likely to engage in ethically questionable actions (Mudrack, Bloodgood, & Turnely, 2011). However, it could be argued Interpersonal Competitiveness has a constructive function. In the current study, 186 MTurk participants completed the Competitiveness Questionnaire (Griffin-Pierson, 1990) to assess their Goal Competitiveness and Interpersonal Competitiveness. Participants were randomly assigned to see and respond to one of four Instagram posts containing different content related to fitness or the outdoors. Regardless of content, greater Interpersonal Competitiveness was associated with greater envy of the post, while greater Goal Competitiveness predicted lower envy. However, only Interpersonal Competitiveness predicted motivation as a response to the post; Goal Competitiveness was not related to these responses. Overall, these findings supported our hypothesis that greater Interpersonal Competitiveness would associated with working out and caring about fitness more, while greater Goal Competitiveness would be associated with working out less.

Undergraduate

*MINDFULNESS MEDIATION AND GENDER EFFECTS ON ANXIETY AND SELF-EFFICACY

Primary Author: Bhoomi Patel, Psychology

Advisor(s): Matthew Zagumny

Several factors influence college students' academic performance. College counselors' top three concerns are anxiety, depression, and stress among student clients (LeViness et al., 2018). Saleh et al. (2017) found that life satisfaction, self-esteem, optimism, self-efficacy, and psychological distress were the most important contributors to stress among students. This study will examine if participating in a coloring activity increases academic self-efficacy, and decreases academic stress and anxiety more than the mindful-based breathing exercise among undergraduates.

Students attended an experimental session during which they completed an informed consent form, pretest measures of the State-Trait Anxiety Inventory (STAI; Marteau, Theresa, Bekker, & Hilary, 1992), General Self-Efficacy Scale (GSE; Schwarzer & Jerusalem, 1995), and Academic Stress and Self-Efficacy Scale (ASF; Zajacova, Lynch, & Espenshade, 2005; Zagumny, McPeak, and Burton, 2014). Participants then completed one of three activities, including either a mandala sheet, recorded mindfulness breathing activity, or a true control treatment. Following the activity, participants completed posttest measures in addition to a demographics questionnaire and debriefing form.

The preliminary results indicate that the average age of the participants (8 males & 15 females) was 20.95 (SD =

2.17). The mindfulness activities had similar effects on state anxiety, academic stress, and academic self-efficacy. Interestingly, state anxiety was reduced in males more than in females for both coloring and breathing exercise [F (1, 16) = 4.52, MSE = .05, p = .049]. A larger sample size could provide significant results for other comparisons.

Undergraduate

*BACKGROUND MUSIC AND READING COMPREHENSION: MUSICAL TRAINING PREDICTS READING COMPREHENSION SCORES

Primary Author: Rachel Pearson, Psychology

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborators: Matthew Zagumny, Tennessee Technological University

Advisor(s): Matthew Zagumny

Research is split on background music's impact on cognitive functioning. Previous research has shown that background music has negative effects on cognitive performance, specifically in the areas of reading comprehension (Chou, 2010; Kämpfe et al., 2011; Patston & Tippett 2011). Musicians have been shown to perform worse on reading comprehension in the presence of music, but with an advantage still present over non-musicians (Patston & Tippett 2011). The current study aimed to examine the effect of background music of different emotions on reading comprehension. Participants attended an experimental session where background conditions (silence or happy, sad, or scary music) while reading a passage were randomly assigned. Musical training and music emotion recognition scores were examined as covariates. Alexithymia was also measured using a scale created by Preece, Becerra, Robinson, Dandy, and Allan (2018). Preliminary analyses found that musical training was a significant predictor of reading comprehension regardless of background condition. Also, regardless of condition, musically trained participants had significantly higher reading comprehension scores than those with no musical training. The preliminary data indicates that the emotion of a piece of background music has no effect on participants' ability to comprehend written information. As previous research has shown, musical training is a significant predictor of reading comprehension as musically trained participants did have higher reading comprehension scores than participants with no musical training regardless of background condition. As these results are from preliminary data, further collection of data may yield significant results for other comparisons.

Undergraduate

WHAT ARE THEY LOOKING AT?: DIFFERENCES IN EMOTIONAL RESPONSES TO PARTNER PHUBBING BASED ON VARYING PHONE CONTENT

Primary Author: Stephanie Shrum, Psychology

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Advisor(s): Nicole Henniger

"Phubbing," is a new term for the common behavior of ignoring our surroundings while redirecting our attention to a mobile device. The current research addresses a gap in phubbing literature by examining how differences in the content presented on the phone during phubbing, and how social that content is perceived as, could affect the jealousy levels of the individuals being ignored.

A sample of undergraduates (n = 174) completed an online survey. Participants were randomly assigned to read a hypothetical scenario (their partner's screen displayed social media, mobile game or book). Next, they reported their perceived sociability level of the content and their overall jealous response.

As we predicted, the mean jealousy scores of the social media condition were the highest (M = 3.11; SD = 1.13), followed by mobile games (M = 2.83; SD = 1.26), and then book (M = 2.44; SD = 1.11). The difference between conditions was statistically significant (p = .012). Additionally, these individuals perceived the social media condition (M = 2.59; SD = .81) as the most potentially social content, followed by mobile games (M = 2.42; SD = .91), and then book (M = 2.12; SD = .82) with a significant difference between conditions (p = .016).

Overall, these findings provide empirical support that, within partner phubbing contexts, higher jealousy levels can be produced when the phone screen's content is perceived to have a higher likelihood of social interaction by the ignored partner.

Department of Curriculum and Instruction

Graduate

*CHEMICAL ENGINEERING LABORATORY CURRICULUM REDESIGN THROUGH APPLICATION OF AN INQUIRY-GUIDED LABORATORY MANUAL

Primary Author: Bobby Adams, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Andrea Arce-Trigatti; Stephanie Jorgensen; Pedro Arce

Advisor(s): Andrea Arce-Trigatti

The purpose of this contribution is to convey preliminary results involving the curriculum redesign of a chemical engineering laboratory course through the novel application of the Inquiry-guided Laboratory Manual (IGLM). The context of this curriculum redesign involves a heat transfer laboratory course, which is the first of the transfer science course series offered by the Department of Chemical Engineering at Tennessee Tech. The pedagogy of the IGLM is anchored in the innovation-driven learning strategies of the Renaissance Foundry and follows a scaffolding approach for inquiry-guided learning that seeks to provide students with learning experiences related to creativity and problem solving. Specifically, the research question embedded in this research design states: How might the application of the IGLM in a transfer science laboratory course influence student activities related to preparation prior to experimentation? The constructivist framework of this qualitative research design is paired with an inductive approach that applies a thematic analysis with open-coding strategies on data that was gathered from the normal coursework of the laboratory curriculum. The design of this study ensures that the preliminary results and themes will be representative of the data from which they emerge and will be further discussed within the study. Moreover, this contribution addresses the need for continued research-based discussions on the curriculum design of engineering laboratories and data-driven conversation on how to provide holistic learning experiences for engineering students.

Graduate

*THE EFFECTIVENESS OF VIDEO MODELING IN TEACHING INDIVIDUALS WITH DEVELOPMENTAL DISABILITIES TO ENGAGE IN LEISURE ACTIVITIES: A REVIEW OF LITERATURE

Primary Author: Goodson Dzenga, Exceptional Learning (Ph.D.)

Co-Author(s)/Collaborators: Krystal Kennedy

Advisor(s): Krystal Kennedy

Leisure activities involve the use of an individuals' free time to engage in activities of one's choices. Leisure

activities are not related to work or any other obligatory activities. Participation in leisure activities plays an important role in developing one's social, communication and cognitive skills, which are essential for successful integration in the community. It is through leisure activities that individuals with developmental disabilities acquire skills and gain competencies that are a prerequisite for successful integration into the general public. Inclusion in the community is linked with an improvement in the quality of life for individuals with developmental disabilities. Most recreational activities for individuals with severe developmental disabilities are selected by parents and caregivers without consulting individuals with developmental disabilities. Video modeling is argued to be one of the evidence-based interventions to teach individuals with developmental disabilities to perform different activities independently. This study reviewed studies that used video modeling to teach individuals with developmental disabilities to engage in different leisure activities. Studies published from 1998 to 2018 (n = 10) were identified and evaluated using the standards of the What Works Clearinghouse (WWC). Results of the study analyzed through Visual analysis and Percentage of Non-Overlapping Data (PND) indicated that video modeling is effective in teaching individuals with developmental disabilities to engage independently in leisure activities, resulting in reduced adult or caregiver dependence. Attendees will understand that literature supports the use of video modeling to teach individuals to engage independently in leisure activities.

Graduate

*USING FANGHANEL'S (2007) FRAMEWORK TO EXPLORE THE MICRO, MESO, AND MACRO FACTORS INFLUENCING UNDERGRADUATE STUDENT MENTORING PROGRAMS

Primary Author: Vincent Okot, Curriculum and Instruction (ED.S.)

Co-Author(s)/Collaborators: Julie Baker, College of Education/Tennessee Technological University; Kara Kara, College of Education/Tennessee Technological University

Advisor(s): Andrea Arce-Trigatti

Successful undergraduate mentoring programs have the potential to help at-risk students achieve academic success, retention, and ultimately graduation (Terrion & Leonard, 2007). Mentoring involves the provision of general guidance, support, and, in some instances, helping a student learn something new. Studies show mentoring also promotes students' sense of well-being by challenging the negative opinions they may have of themselves and demonstrating that they can have positive relationships with adults (Coles, 2011). In most instances, the success of such mentoring programs at the university level not only relies on the effectiveness of the mentor-mentee relationship, but also the effectiveness of the coordinator of the program (Pfund, 2016). However, the role that the coordinator plays in the effectiveness of these programs is less understood.

In order to better understand these dynamics, this exploratory, theoretical case study will use Fanghanel's (2007) framework (i.e., Micro, Meso, and Macro levels) to draw conclusions from observational data collected from one semester on two undergraduate mentoring programs from the coordinator's perspective. Specifically, the results of this analysis indicate that at the Micro level, issues pertaining to approach, networking, training, and expectations are important, whereas at the Meso and Macro level, feedback, logistics, listening, and holistic planning are valuable. The implications from this study provide actionable items that can be used to improve undergraduate mentoring programs from the perspective of the coordinator's responsibilities. Conclusions for this study will provide avenues for future research that explores the mentees' perspectives on the effectiveness of these approaches.

Graduate

*CONTENT ANALYSIS OF INTERNATIONAL STEM EDUCATION RESEARCH JOURNALS

Primary Author: Miguel Perez, Exceptional Learning (Ph.D.)

Co-Author(s)/Collaborators: Britney Campbell-Gulley; Carey Wilson; Meghan England

Advisor(s): Holly Anthony

STEM education emerged as a focus for educators and researchers in the United States as more states and schools implement integrated, STEM-driven curricula and instruction in order to improve students' STEM literacy, critical thinking skills, and 21st century workforce skills (Bybee, 2013). This study used content analysis (Grbich, 2013; Hsieh & Shannon, 2005) to investigate recent trends in STEM education research by analyzing all of the published articles in three international STEM education research journals. The criteria for journal selection were publication origination date, number of articles published, and ability to obtain the journals through student-accessible databases or journal websites. Data included the number and types of STEM subjects, whether or not the STEM subjects were integrated, the date of publication, and the setting and participants. Findings from this study suggest that STEM education research articles tend to focus on two or more STEM silos, with the number of iSTEM education research articles increasing in publication over time. Future research in STEM education should include K–12 settings to complement the work already being performed in higher education settings.

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Graduate

*TEACHERS' VIEWS ON FLEXIBLE SEATING IN 2ND GRADE

Primary Author: Larissa Rector, Literacy & Research Ph.D.

Advisor(s): Janet Isbell

In this interpretive qualitative case study, I observed, interviewed, and collected documents from three 2nd grade teachers at a suburban Tennessee school in order to provide insight into teachers' use of flexible seating, and the way the seating arrangement impacts their classroom management and instruction. Theories, such as Glasser's choice theory, proclaim that student success is enhanced when students share classroom responsibilities and make decisions about their own learning and behavior. Flexible seating is said to empower the child with some degree of control over their learning environment, while still enabling teachers to retain the role of classroom manager.

Undergraduate

*SMARTS-STEM, MULTICULTURALISM, AND THE ARTS: A FRAMEWORK FOR THE INTEGRATION OF CULTURAL INCLUSIVITY IN EDUCATIONAL OUTREACH UTILIZING THE RENAISSANCE FOUNDRY MODEL

Primary Author: Payton Womack, Elementary Education

Co-Author(s)/Collaborators: Mohera Narimetla; Kellie Malone

Advisor(s): Andrea Arce-Trigatti

Research suggests integrating the arts into Science, Technology, Engineering, and Mathematics (STEM) curriculum is essential in the recruitment of an interdisciplinary workforce necessary to meet the challenges of the modern world. However, this initiative fails to acknowledge cultural and historical narratives and considerations within academia, a field primarily dominated by interests of atypical western norms with only 22 percent of minority groups represented in the post-secondary setting. Furthermore, to address this representation issue, the intentional integration of multiculturalism is essential. The work presented offers insight into the preliminary stages of a service-learning project born from the STEM Foundry Heritage Fellows program at Tennessee Technological University. By using the Renaissance Foundry Model, a team of students worked in community and program planning to establish a framework for including multiculturalism into STEM entitled SMARTS: STEM, Multiculturalism, and the Arts. The purpose of this work is to provide an analysis of how the Foundry offered a platform to help the team form this concept. Data from assignments, reflections, and planning will form the basis of this analysis. Understanding how the Foundry can transform student learning to help identify and address complex issues like the lack of multiculturalism in STEM is vital to transforming the landscape in these fields. This study will provide recommendations for other community-based learning projects that are geared toward integrating diversity and inclusion into vital conversations surrounding outreach, community interactions, and inclusion in STEM education.

Department of Exercise Science, Physical Education and Wellness

Undergraduate

THE EFFECTS OF DIFFERENT TYPES OF STRETCHING ON LOWER BODY POWER

Primary Author: Grant Phillips, Pre-Professional

Co-Author(s)/Collaborators: Chris Vaughn

Advisor(s): Michael Phillips

In today's athletic community, stretching has become a widely debated topic in retrospect of its effectiveness to the athlete and the benefits it can provide. By knowing how to properly warm up, trainers, strength and conditioning coaches, and sports coaches can implement this data to better improve their athletes' performances. This study compared static and dynamic stretching and their effects on lower body power. Fifteen traditional college students, both male and female, were tested along with one non-traditional student. The participants were tested on two separate days with one day of rest in between. Both days consisted of 7-8 minutes' worth of stretching and focused on four muscle groups consisted of the hip flexors, plantar flexors, hamstrings, and quadriceps. Specific instructions were given and two attempts were used per participant for the vertical jump test. Scores for both tests were recorded and the dynamically stretched portion of the test showed a 3.87% increase in jump height when compared to the statically stretched portion. The authors conducted an independent groups t-test to determine if there was a significant difference between the two stretches. The results showed that there was not a significant difference between the two types of stretches tested ($p = 0.2$). This can be explained from the low sample size and number of tests ran. In conclusion, dynamic stretching showed the increase in lower body power. Therefore, dynamic stretching could be utilized as a method of preparing athletes and non-athletes alike for lower body power movements.

Undergraduate

*IS THERE A RELATIONSHIP BETWEEN BMI AND GRIP STRENGTH?

Primary Author: Kelsey Sanders, Exercise Science, Physical Education and Wellness

Co-Author(s)/Collaborators: Maddie Ramsaur; Challice Ledford

Advisor(s): Michael Phillips

The purpose of this study was to determine if there was a relationship between body mass index (BMI) and grip strength. This study could benefit healthcare professionals in understanding the relationships between various aspects of the body. Since the body is connected, knowledge of these different relationships can help athlete performance, medical prescriptions, and recovery processes. The study was conducted on 24 Exercise Science students varying from ages 18-22. The participants were instructed to follow specific procedures to obtain correct data for BMI and grip strength. After running a correlation on the students' data, the results showed a positive and moderate correlation between BMI and grip strength (r-value .42). In conclusion, the results indicated that BMI lacked explanatory power on an individual's grip strength (R2 = .17). Further research is needed on this topic since there is a correlation, but it does not allude to an explanatory value. To find which variable provides a higher degree of explanatory value, a more in-depth study needs to be conducted.

Undergraduate

*IS THERE A RELATIONSHIP BETWEEN BMI AND BLOOD PRESSURE

Primary Author: Mary Walker, Exercise Science, Physical Education and Wellness

Co-Author(s)/Collaborators: Thomas Carver

Advisor(s): Michael Phillips

The purpose of this study was to determine if there was a relationship between body mass index (BMI) and systolic blood pressure. A strong correlation between these measurements would allow us to educate the population on the effects of BMI on hypertension, helping the population counteract the effects of hypertension. The study included 16 Exercise Science majors ranging in age from 20 to 33. Participants were initially surveyed to determine if they had followed requested protocol, which included abstaining from food, alcohol, nicotine, caffeine, and participation in exercise 30-minutes before testing. Each participant's blood pressure was taken, along with his or her height and weight to calculate BMI. The results showed that there was a positive and moderate relationship between BMI and systolic blood pressure (r = .45). In conclusion, the results indicated that BMI lacked explanatory power on a person's blood pressure.

College of Engineering

Department of Chemical Engineering

Graduate

*EFFECT OF INTERFACIAL MASS TRANSPORT LOSSES AT THE ULTRATHIN FILM CATALYST LAYER TO DIFFUSION LAYER OF A PEMFC AT SUB-ZERO CONDITIONS

Primary Author: Abayomi Adeleke, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Cynthia Rice, Fuel Cells Materials, Testing and Diagnotics Lab

Advisor(s): Cynthia Rice

In the race for a viable alternative source of power for internal combustion engines, automotive polymer electrolyte membrane fuel cell (PEMFC) continues to be one of the leading commercially viable options. This is due to their lack CO2 emission, high efficiency and adaptability. However, factors inhibiting effective commercialization of PEMFC includes low power density, reliability at sub-zero temperature and prohibitive cost of production. The cost of catalyst is being reduced by increasing the activity and reducing the loading from 0.4 mgPt/cm2 to below 0.1 mgPt/cm2. This results in nominal operational mass transport losses at the diffusion media/ catalyst layer interface. It is anticipated that subzero losses will be exacerbated due to limited reactant diffusivity and proton conductivity.

This research attempts to investigate the mass transport mechanisms of dilute oxygen at the interface between the cathode catalyst layer and the diffusion media of a PEMFC at sub-zero conditions. At -20°C isothermal water fill tests will be performed to assess the water fill capacity of the cathode catalyst layer and the related O2 concentration dependent voltages and hydration dependent ionic conductivity. The interfacial losses at the interface of the ultra-thin film catalyst layers of a PEMFC will be determined by altering the diffusivity with the carrier gas. By varying the diluents (i.e. N2, He, and Ar), we wish to establish the relationship between different carrier gasses and diffusivity of O2 at the gas diffusion layer.

Graduate

*MODELING A PHOTOCATALYTIC REACTOR: WATER CONTAMINANT DEGRADATION, ENERGY PRODUCTION, AND THE RADIATION FIELD

Primary Author: Sabrina Buer, Environmental Sciences PhD Concentration: Integrated Research

Co-Author(s)/Collaborators: Pedro Arce; Sunil Rawal

Advisor(s): Pedro Arce

As the amount of human and industrial waste in the environment increases, the need for more effective and efficient water treatment methods is higher than ever. Current wastewater treatment processes have been found to be ineffective against a growing number of contaminants, including pharmaceutical compounds. Coupled with the necessity of pharmaceutical-free water, energy sources that are easily produced, affordable, and environmentally-friendly are a growing societal need. This project will employ two methods of approach to address the issues of pharmaceutical degradation and energy production. The first method will employ thin-film photocatalysis to achieve simultaneous contaminant degradation and hydrogen gas production as an energy source. The second method will utilize the development of a mathematical model of the reactor system, intended for future use as an upscaling

mechanism to be used in wastewater treatment facilities.

Graduate

*NANO-SIZED LITHIUM ALUMINUM LAYERED DOUBLE HYDROXIDES IN LITHIUM ION EXTRACTION

Primary Author: Iulia Coultis, Chemical Engineering (M.S.)

Co-Author(s)/Collaborators: Viviana Cruz; Tessa Eskander, Bachelors of Chemical Engineering at Tennessee Technological University

Advisor(s): Holly Stretz

Increasing world demand for lithium is driving innovation in lithium-ion extraction. Current methods employ open-pit mining and salt-lake evaporation. Layered double hydroxide chlorides (LDH) have shown to be effective sorbents of metal ions. Lithium-Aluminum LDH is an environmentally-friendly alternative to selectively extract lithium ions from brine lakes. In this poster, Li-Al LDH on the nanometer scale is compared to larger particles synthesized by ORNL; the smaller nano-particle size corresponds with a higher surface area and thus better adsorption of lithium. Size, structure, and chemical makeup of Li-Al LDH are characterized via DLS, SEM, and XRD respectively. The adsorption isotherms of the nano-scale and larger Li-Al LDH samples are compared via ICP-OES testing.

Graduate

*THE ROLE OF THE AREA AVERAGING APPROACH TO DERIVE MACROSCOPIC SCALED TRANSPORT EQUATIONS FOR HYDROGEL CAPILLARIES

Primary Author: Kurt Dunham, Chemical Engineering

Co-Author(s)/Collaborators: Robby Sanders, Tennessee Technological University Department of Chemical Engineering; Stephanie Stephanie, Tennessee Technological University Department of Chemical Engineering

Advisor(s): Pedro Arce

A hydrogel is a three-dimensional network of chemically or physically cross-linked polymers. Hydrogels have porous structures at the nanometer scale and are able to contain large amounts of water without changing their structure. Hydrogels are widely used for gel electrophoresis, which is a technique to separate biomolecules, such as proteins, nucleic acids, and pharmaceuticals, for industrial, biological, and environmental processes. During gel electrophoresis, biomolecules migrate through pores of varying shapes and sizes in the presence of an electric field and separate according to their size and charge.

This research aims to develop and systematize a technique for the analysis of the microscopic transport equations that describe gel electrophoresis at a local level, within a capillary of the hydrogel material, and upscale them to macroscopic equations using a technique known as area averaging. The results of the research efforts will be twofold. First, the research efforts will develop a systematization of the area averaging technique that is currently disorganized in the literature and difficult to apply and generalize. Second, the research efforts will produce constitutive equations for the effective transport coefficients including the effective diffusivity and the effective mobility of the biomolecules in the material capillaries.

The migration of a biomolecule through a pore during gel electrophoresis may be modeled using these transport equations and other anticipated equations, allowing for connection to macroscale parameters that are able to be measured experimentally.

Graduate

*RHEOLOGICAL AND TURBIDIMETRIC CHARACTERIZATION OF EARLY-PHASE WOUND GELS

Primary Author: Jonathan Garvin, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Dennis Piercy; Stephanie Jorgensen; Robby Sanders

Advisor(s): Robby Sanders

Treatment of dermal wounds and development of new techniques by which dermal wound healing can be accelerated with minimal scarring are of global interest. During the early stages of the wound healing process, a loose platelet plug is stabilized by the formation of a fibrin gel matrix. A fibrin gel is formed when the protein fibrinogen is enzymatically cleaved by thrombin and crosslinked by Factor XIII. These fibrin matrices help to halt blood flow from the wounded site and serve as a scaffold by which cell transport and adhesion may occur. Various medical disorders, deficiencies, and diseases can result in abnormal wound healing, i.e. scarring or inability to form stable, lasting clots. The study of these bio-gels is expected to result in advancements in wound healing techniques and a better understanding of the behavior of dermal wounds, transport of cellular and other items through such wounds, and resultant scarring control. Towards this end, rheological techniques were explored to characterize structural properties of such early-phase wound media during gel formation. Fibrin gels were prepared using 1, 3, 6, and 12 mg/ml fibrinogen, 1 U/ml thrombin, and 5mM CaCl2, final concentrations. Rheology and turbidity data indicate that gels formed in the presence of higher fibrinogen concentrations develop more rigid structures sooner than those formed at lower fibrinogen concentrations. Such results provide a foundation for future studies to explore the effects of mixing and the influence of modified versions of fibrinogen on gel properties and species transport through such gels.

Graduate

*THE INFLUENCE OF PRE-ELECTROPHORESIS ON RHEOLOGICAL PROPERTIES OF POLYACRYLAMIDE GEL

Primary Author: Anfal Haris, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Jacob S. Ramaker; Pedro Arce; Robby Sanders

Advisor(s): Pedro Arce

Hydrogels are crossed-linked polymers, which have been used in various biomedical applications including tissue engineering, drug delivery, and gel electrophoresis. Since controlling the internal morphology of these polymers is an important process in selecting appropriate conditions for a specific function of the hydrogel materials, characterization of the hydrogel properties, such as swelling ability, mechanical properties, and pore sizes is very crucial. Polyacrylamide hydrogels are widely used to separate proteins based on their charge, molecular weight, mobility, etc. Polyacrylamide gels were treated by “pre-electrophoresis”, i.e. the application of an electrical field to the gel before protein separations take place, and this showed an excellent improvement on the separation by electrophoresis of protein mixtures. We have hypothesized that the treatment led to a modification of the internal morphology of the gels that it would be important to characterize. Rheology is an appropriate technique for characterizing hydrogel mechanical properties since it is quick, precise, and can show the differences in structure such as degree of crosslinking and stability on the rheological properties. In this research, the effect of pre electrophoresis on hydrogel porous structure is investigated by comparing the viscoelastic properties of two types of gel samples (one treated with pre-electrophoresis and the other that is not) with the same acrylamide concentration.

The results show the effect of electrical field on the viscoelastic properties of the treated gel with respect to the regular gel. We infer that these are linked to a modification of the internal morphology by the pre-electrophoresis treatment.

Graduate

*CHARACTERIZATION AND APPLICATION OF LABORATORY GRADE NANOSCALE EGYPTIAN BLUE

Primary Author: Agoston Kiss, Chemical Engineering (M.S.)

Co-Author(s)/Collaborators: John Clark

Advisor(s): Holly Stretz

Calcium copper silicate (CaCuSi4O10), known as Egyptian Blue (EB), is a pigment that exhibits a strong near-IR (910 nm) fluorescent emission when exposed to a strong visible light source. This property makes it a novel candidate for use as a basis for nanomaterial-based sensors in surface water, as its IR signal is very strong in comparison with current commonly used IR reporters. Also, IR signals penetrate biological samples better, and are scattered less than visible range signals. A sample of EB was synthesized by a solid-state reaction outlined by Johnson-McDaniel and Salguero. In order to reduce the particle size to nanoscale, exfoliated EB powder and exfoliated EB powder covered with cetyltrimethylammonium bromide were prepared. The powders were adhered to glass discs in conjunction with (3 aminopropyl)triethoxysilane to develop lenses that fluoresce in the near-IR spectrum. Dynamic light scattering was performed to obtain information on particle sizes. Phase shifting interferometry was performed to characterize the surface coatings of the glass discs and to obtain the size distribution of the adhered nanoparticles. The performance of the glass discs was characterized by photoluminescence spectroscopy.

Graduate

*MOLECULAR DYNAMICS STUDY OF STRUCTURAL AND FLOW PROPERTIES OF POLYELECTROLYTE-GRAFTED NANOPARTICLES IN A SOLUTION

Primary Author: Koteswara Rao Medidhi, Engineering (Ph.D.)

Advisor(s): Venkat Padmanabhan

Polyelectrolytes have found applications in fuel cells, solar cells, membranes, etc. Here, we investigate the structural and flow properties of polyelectrolyte grafted nanoparticles (PENP) in a solution using coarse-grained molecular dynamic simulations. The degree of ionization (pH) and the concentration of PENP in solution are systematically varied. For low pH, the flow properties are dominated by grafted chain entanglements, while at high pH, the strong electrostatic repulsions between the ionized groups are the major factor. At intermediate pH, the hydrogen bonding between the ionized and non-ionized groups along with the concentration of PENP plays a significant role in dictating the solution viscosity. At low PENP concentrations, intra-particle hydrogen bonds are formed that lowers the viscosity, while at higher concentrations, inter-particle hydrogen bonds are formed enhancing the viscosity of the solution.

Graduate

*STATIONARY 2D COMPUTATIONAL PRINTING OF CEMENT-BASED PASTES

Primary Author: Abdul Salam Mohammad, Engineering (Ph.D.)

Advisor(s): Joseph Biernacki

Additive manufacturing (AM or 3D printing) offers the

cement-based construction industry new opportunities to improve construction efficiency, and to increase the reliability of concrete infrastructure. The 3D printing of cement-based materials requires two paste characteristics: (1) extrudability, (2) resistance to deformation under layering load. Thus, designing cement pastes for 3D printing applications is related to the rheological (flow) characteristics of the material, e.g. yield stress, plastic viscosity and time-dependent effects, and design strategies and data correlating rheological properties to printability are among the existing research gaps. In an effort to close these gaps, this work introduces an efficient new computational printing strategy for predicting the flow behavior of cement pastes. A rheometer and a mini conical slum flow test was used to experimentally establish fluid properties and to calibrate rheological models prior to conducting computational experiments. The relative importance of rheological properties such as yield stress, plastic viscosity and structuration rates were quantified. The objective of this study was to link relevant experimentally determined rheological measures of printing pastes to computer generated 3D printed constructs in an effort to correlate properties to printability metrics and to target optimal paste design parameters.

Graduate

*TIME DEPENDENT RHEOLOGICAL BEHAVIOR OF PARTICULATE SUSPENSIONS

Primary Author: Babajide Onanuga, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Edward Garboczi, National Institute of Standards and Technology, Boulder, Colorado

Advisor(s): Joseph Biernacki

Many industrial materials of importance in manufacturing processes are neither pure liquid nor pure solid but rather are mixtures of both. Examples of such materials are particulate suspensions which are heterogeneous mixtures in which the solute particles do not dissolve, but are rather suspended throughout the bulk of the solvent. Understanding the rheology of such particulate suspensions is important in many industrial applications, including coatings, paints, food, pharmaceuticals, and cements and where pumping and extrusion are used, among others.

For cement paste suspensions, it is rheology that is critical to its suitability for use in construction applications, including 3D printing. Rheology depends on a number of physical and chemical properties of the cement and the paste formed thereof. Furthermore, the way that the paste was processed matters, including how it was mixed and even the measuring protocol. Critically important is the need to separate the effects of these factors on the rheology of cement paste, which has been shown to depend not only on the shear history of the paste, but also on the age of the paste i.e., properties evolving with time, thus exhibiting time-dependent rheological behavior.

The ability to be able to control the rheological evolution of cement paste is crucial to achieving structurally sound materials in large-scale 3D printing applications. This work attempts to separate the contribution of chemical factors, i.e. hydration, from the overall time-dependent rheological behavior of cement-based pastes.

Graduate

*MOLECULAR DYNAMICS SIMULATION ON HUMAN BETA DEFENSIN TYPE 3 BINDING WITH CXCR4 RECEPTOR

Primary Author: Jackson Penfield, Chemical Engineering

Advisor(s): Liqun Zhang

Human beta defensin type 3 (hBD-3) is a cationic peptide belonging to the human innate immune system and mainly secreted from human epithelial tissues and mucosa. It has bactericidal activity and can bind with chemokine

receptor CXCR4 as an antagonist. It is capable of forming three pairs of intramolecular disulfide bonds which help restrain its structure, each of which break in a particular order in a reducing environment. Chemotactic activities of the naturally occurring structure (wildtype) with three disulfide bonds connected may differ greatly from a linear-analog structure. hBD-3 may also form a dimer at high concentrations in solution. CXCR4 is a membrane-bound G-protein coupled receptor (GPCR) involved with chemotaxis in lymphocytes. Because CXCR4 is involved with some inflammatory diseases and in the replication of HIV-1, it has become a target of interest for therapeutic control. This study focuses on structural changes that can modify the chemotactic activities of hBD-3. A clear understanding of the function of hBD-3 as a CXCR4 antagonist is important for development of a novel endogenous treatment. All-atom molecular dynamics simulations were performed on hBD-3 monomer and dimer in both wildtype and analog forms interacting with the CXCR4 receptor embedded in a lipid bilayer (POPC and POPG bilayers were tested). Results currently support a monomer structure binding with the second extracellular loop of CXCR4 to suppress signal transduction. Dimers of hBD-3 binding to CXCR4, and simulations with CXCR4 in POPG lipids have proven to be mostly unstable in microsecond scale simulations.

Graduate

*ADVANCED OXIDATION OF ACETAMINOPHEN FOR WASTE WATER TREATMENT: TESTING A NEW APPROACH FOR DEGRADATION BY PHOTOCATALYTIC METHODS VIA TIO2 FILMS

Primary Author: Sunil Rawal, Environmental Sciences Chemistry (Ph.D.)

Co-Author(s)/Collaborators: Sabrina Hurlock-Buer

Advisor(s): Pedro Arce

Traditional Wastewater Treatment Plants (WWTP) have not been designed to handle pharmaceutical-based contaminants efficiently, therefore, cannot completely eliminate drug residues. As a result, its metabolites can be found in groundwater, surface water and even in drinking water. Therefore, the purpose of this research is to develop and test a new approach for the degradation of acetaminophen in water. This method is based on the use of Titanium dioxide (TiO2) thin films to replace the current costly use of nanoparticles in batch-designed systems, which require the elimination of particles by filtration as a tertiary method of treatment in WWTP.

This contribution describes the preparation and characterization of TiO2 thin films, and the degradation rate by using the prepared thin films. Multiple layers of the TiO2 thin film (6, 8 and 10) were prepared and deposited onto a microscopic glass slide via the sol-gel method. The deposited TiO2 thin film on the glass substrate was characterized using X-ray diffraction, and scanning electron microscopy. Four and six TiO2-deposited thin-film glass slides were used to determine the photocatalytic degradation rate of acetaminophen with different pH ranges. The degradation rate of acetaminophen was observed by UV-Vis Spectrophotometer at a wavelength of 243 nm. The favorable degradation efficiency, ~ 44% was achieved by using six glass slides with ten coating layers of the photocatalyst in a neutral medium. Over a period of 90-minutes, the increase in number of thin-film slides showed a substantial increase in the degradation rate due to the increase in surface area.

Graduate

*RECOMBINANT PRODUCTION OF FIBRINOGEN FOR WOUND HEALING

Primary Author: James Shanks, Chemical Engineering (M.S.)

Advisor(s): Stephanie Jorgensen

Fibrinogen is a critical protein that is necessary, with the help of thrombin, to facilitate the process of wound healing. Studying how fibrinogen clots in the presence of thrombin and other clotting factors is beneficial in developing new techniques and materials to improve the wound healing process, resulting in less scarring. Unfortunately, as part of the purification process, most commercial fibrinogen comes prepackaged with factor XIII or other clotting factors with unknown quantities. Given these factors influence the clotting process, a lack of detailed information regarding the quantities of these contaminants makes it difficult to interpret results. By incorporating the necessary genes for production of fibrinogen into mammalian cell cultures that can be grown in the lab, fibrinogen can be extracted and purified. Creating a means to produce fibrinogen in the lab that gives pure samples from which one can add known quantities of various clotting factors to determine exactly how it is affecting the resulting clot represents an important next step. Additionally, this approach enables the ability to directly modify the genes to modify the fibrinogen protein that would be expected to result in changes to the forming clot, the results of which can then be studied and associated with various diseases in which mutations in the fibrinogen protein are known to occur. By incorporating human fibrinogen genes in mammalian cells, growing cell cultures, and isolating fibrinogen, the fibrinogen obtained is expected to be useful in understanding of the various effects of the species involved in wound healing.

Graduate

*MOLECULAR DYNAMIC SIMULATION AND CHARACTERIZATION OF GEL-FORMING POLYMERS FOR CEMENT-BASED 3D PRINTING APPLICATIONS

Primary Author: Hajar Taheri, Chemical Engineering

Co-Author(s)/Collaborators: Venkat Padmanabhan; William Carroll; Edward J.Garboczi

Advisor(s): Joseph Biernacki

Additive manufacturing (3D printing) of cement-based materials is a promising method for improving construction efficiency that is attracting much attention from researchers, entrepreneurs and industrial concerns, large and small. The use of suitable chemical additives (admixtures) that provide properties needed for 3D printing of cement-based pastes is still a challenge. This work proposes three different types of gel-forming polymers as printing aids. However, not all gel-forming polymers provide the properties necessary for printing. This research is linking the physical and chemical characteristics of the polymer hydrogels to differences in printability results using a variety of experimental probes including differential scanning calorimetry (DSC), NMR-diffusion ordered spectroscopy (DOSY) and gel and paste rheology along with molecular dynamic simulations. Conjectures based on objective measures of printability and physical and chemical-molecular characteristics of the polymer gels are emerging that should help target better mix formulation and printing aid selection and design. The class of hydrogels explored exhibit time-independent shear stability, a characteristic that is a pre-requisite for printing aid applications. These particular gels are also highly shear-thinning and produce workable, but cohesive pastes when mixed with cement. While notable differences in gel-pore structure and the amount of confined water are quantifiable, it is not so clear how or if these factors are directly related to printability. Finally, the formation of hydrogen bonds between the polymer and the surface of cement particles appears to positively influence gel efficacy as a printing aid.

Graduate

*PHOTOCATALYTIC METHODS FOR CONTAMINANT DEGRADATION AND HYDROGEN PRODUCTION IN WASTE WATER USING SOLAR/UV RADIATION

Primary Author: Dipendra Wagle, Chemical Engineering
Co-Author(s)/Collaborators: Robby Sanders

Advisor(s): Pedro Arce

Photocatalyst-based advanced oxidation processes have been reported as a useful treatment approach for waste water decontamination purposes including for removal of medicines, organic chemicals, and for bacterial disinfection among others. The technique is also beneficial for hydrogen production simultaneously to the elimination of contaminants. The optimization and upscaling of this technology for large scale implementation has established big challenges for environmental engineers.

Most of the photocatalytic methods for contaminant degradation are based on the TiO2 semiconductor photocatalyst which is readily available, environmentally friendly, and possesses significant photocatalytic activity. The big challenge associated with this is that it is photo-responsive only in the ultraviolet region that comprises only 4% of the solar spectrum falling on Earth. Therefore, synthesis of a new photocatalyst or, alternatively, the modification of the TiO2 for a cost-efficient visible-light-responsive photocatalyst that is capable of both mineralizing contaminants and producing hydrogen is a desirable project goal. For example, modification of TiO2 crystals by doping with other co-catalysts such as CdS, MoS, etc. and novel metals is expected to be an excellent potential approach for this purpose so that the composite system potentially will display a broad spectrum for photoresponse.

This research focuses on developing a general technique to synthesize an efficient CdS doped TiO2 photocatalyst for carbamazepine degradation. In addition, structural characterization of this catalyst and the evaluation of the kinetics of photocatalytic degradation in UV and visible light will be performed. Comparisons with current literature values for validation of the catalytic material will be also included.

Graduate

*CALCULATING THE BINDING FREE ENERGY OF HUMAN BETA DEFENSIN TYPE 3 WITH NEGATIVELY CHARGED MEMBRANE

Primary Author: Rabeta Yeasmin, Chemical Engineering

Co-Author(s)/Collaborators: Liqun Zhang

Advisor(s): Liqun Zhang

Human beta defensin type 3 (hBD-3) is a small antimicrobial peptide with 45 residues and a charge density of +11. It is usually expressed in human epithelial cells and shows antimicrobial activity against both Gram-positive and Gram-negative bacteria in a salt-insensitive manner. It forms a dimer at high concentration in solution. It is believed that hBD-3 interacts with bacteria by disrupting its membrane. In this study, we investigated the binding free energy of the residues on hBD-3 with a model membrane consisting of pure POPG lipids, because both Gram-positive and Gram-negative bacterial membranes consist of POPG lipids at high concentration. As it is quite complicated to calculate the absolute binding free energy, we calculated the relative binding free energy of hBD-3 with POPG lipid resulting from the point mutation of the residues to Alanine. The alchemical free energy changes have been calculated by running two free energy perturbation simulations of the mutation. The simulations are run in NAMD at a temperature of 300.15 K and a pressure of 1 atm, dividing the whole process into 20 different thermodynamic windows and running each window for 3ns in the bound state and 2ns for unbound state simulation. The free energy result shows that the Arginine 17, Arginine 36 and Arginine 43 bind quite strongly with the POPG lipid compared to the other residues contributing to a total binding free energy of –9.1297 kcal/mol out of -28.388 kcal/mol.

Undergraduate

*THE ROLE OF STRONG HYDROGEN BONDS IN HUMIC ACID

Primary Author: Viviana Cruz, Chemical Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Holly Stretz, Tennessee Tech

Advisor(s): Holly Stretz

With the growing demand for drinking water, purification processes must be operating at maximum efficiency. It has been found that humic acids are useful in removing toxic metals, oil, liquid organics, and other suspended matter; however, during the purification process these molecules have been found to aggregate and potentially create fouling and other undesirable effects. This can result in less efficient purification systems which is why it is important to understand humic acid molecules on a molecular level. It is currently thought that these molecules contain strong hydrogen bonds, which is assumed to be the driving force of aggregation. In this project, the goal is to achieve an understanding of the role of strong hydrogen bonds in the supramolecular assembly on a fundamental level and provide insight into the evolution of humic acids structure and its dependence on shear stress.

Undergraduate

*STRUCTURE AND OLIGOMERIZATION INVESTIGATION ON HUMAN BETA-DEFENSIN TYPE 3

Primary Author: Lela Fine, Chemical Engineering

Advisor(s): Liqun Zhang

Human Beta-Defensin type 3 (hBD-3) is a natural antimicrobial peptide. It belongs to the human innate immune system, and is a potential candidate for novel drug development. In order to understand its structure and function relationship, it is important to study and analyze its structure and oligomerization in solution as the first step. All-atom molecular dynamics simulations are performed in this project with the goal to understand its oligomerization in the solvent.

A 0.0183M solution of hBD-3 in a box of water was mixed with 0.15M NaCl to create the simulation conditions. 20 repeat simulations each starting from a different random number were each conducted for 40 ns using NAMD program and CHARMM forcefield. The trajectories were analyzed with VMD software. The formation of oligomer states in solution, including dimer, trimer and tetramer was analyzed and the duration of each oligomer state in the simulation was calculated then averaged based on the total valid runs. It was found that hBD-3 can form oligomer structures ranging from a dimer to a hexamer in the solvent at room temperature and 1 atm at the simulation concentration. The dimer structure of hBD-3 had the highest average duration and frequency, which may suggest that it is the most favored and potentially the most stable oligomer state of hBD-3 in the solvent.

Undergraduate

*STRUCTURE AND DYNAMICS OF HUMAN BETA DEFENSIN INTERACTING WITH BACTERIAL LIPID MEMBRANES

Primary Author: Nutchanok Keerakiatwong, Chemical Engineering

Co-Author(s)/Collaborators: Liqun Zhang

Advisor(s): Liqun Zhang

Human Beta Defensins (hBD) are antimicrobial peptides

which are produced as a first line of defense by all multicellular organisms. These proteins can have broad activities to directly kill bacteria, yeast, fungi, viruses and even cancer cells. hBD has 6 family members, from hBD type 1 (hBD-1) to type 6 (hBD-6). They have distinct antibacterial activities although sharing similar structures. In this research, human beta defensin type 1 (hBD-1) and type 3 (hBD-3) are studied in order to acquire a better understanding of the structures and dynamics of both proteins. Firstly, we set up simulations on hBD-3 monomer and hBD-1 dimer binding with both gram-positive and gram-negative bacterial lipid membranes and ran for 50 ns each. Then we analyzed hBD on the bacterial membrane simulation trajectories by calculating Root Mean Square Deviation (RMSD), Root mean square fluctuation (RMSF), the number of hydrogen bonds of hBD-1 and hBD-3 with lipids, orientation of lipids around protein and membrane thickness. It is found that hBD-3 forms more hydrogen bonds with the gram-negative and gram-positive membranes than those of hBD-1, and hBD-3 has more stable binding on bacterial membranes than hBD-1. The result can help to explain the binding and activity discrepancy of hBDs during bacterial eliminating.

Undergraduate

*OPTIMIZATION OF MASS TRANSPORT WITHIN DIRECT FORMIC ACID FUEL CELL CATALYST LAYER VIA PORE FORMERS

Primary Author: Steven Lam, Chemical Engineering

Advisor(s): Cynthia Rice

In today's society, batteries have become a vital necessity for portable power, but lengthy recharging times, limited charge capacity, and tendency to degrade exponentially over time make batteries an inefficient power source. Direct formic acid fuel cells are a sustainable alternative to the battery due to their larger charge capacity, high efficiency, and small size. However, due to the two-phase flow on the anode and the low pore size between agglomerates in the catalyst layer (~20 nanometers), mass transport limitations plague the performance of the fuel cell. To maximize the performance, the transport of the reactant, formic acid, and the product, carbon dioxide, must be optimized. Previous work by the Rice research group has shown an increased performance by increasing the pore size of the catalyst layer from ~20 nanometers to ~10 micrometers with lithium carbonate particles. This research aims to investigate the use of magnesium oxide as an alternative pore forming template to increase the pore size between agglomerates to ~50 nanometers and increase the mass transport within the catalyst layer. Current work shows improved catalytic activity due to the increase in the porosity.

Undergraduate

ACCELERATED STRESS TESTS: IN-SITU ANALYSIS OF THE EFFECT OF THE IONOMER TO CARBON RATIO ON CATALYST DEGRADATION IN FUEL CELLS

Primary Author: Ricky Matos, Chemical Engineering

Co-Author(s)/Collaborators: Abayomi Adeleke; Cynthia Rice, Fuel Cells Materials, Testing and Diagnotics Lab

Advisor(s): Cynthia Rice

Proton exchange membrane fuel cell (PEMFC) are viewed to be a suitable option to internal combustion engine but the technology has continued to face durability issues especially in automotive system usage. As per the US Department of Energy, the 17000 start/stop cycles and 1.2 million idle to peak cycles target has primarily remained a hurdle because these are largely influenced by cathode catalyst layer due to rapid voltage change induced loss of electrochemical surface area of the carbon supported platinum nanoparticles.

This work focuses on the accelerated stress test performed on the cathode catalyst layer at 70°C assembled in a subscale single cell PEMFC fixture (in-situ). An accelerated stress test is performed by cycling the voltage from open circuit (idle between 0.9 and 1.2V, upper potential limit) to on load (0.6V, lower potential limit) up to 25,000 times. The influences of the ionomer-to-carbon ratio (0.6 – 1.5) and carbon support type (low surface area (250 m2/g) and high surface area (800 m2/g)) are analyzed. Increasing the ionomer-to-carbon ratio increases the acidity of the catalyst layer and results in higher rates of voltage induced electrochemical surface area degradation. Compared to thin film tests performed in liquid electrolyte (ex-situ) the initial decay of the in-situ electrochemical surface area with accelerate stress testing is reduced.

Undergraduate

*MATHEMATICAL MODELING OF BIOMASS PYROLYSIS USING DISCRETE ELEMENT METHOD

Primary Author: Mohera Narimetla, Chemical Engineering

Advisor(s): Joseph Biernacki

As fossil fuels and other forms of carbon-based resources become increasingly scarce and environmentally detrimental, renewable sources of energy have progressively become the subject of green research. Because of its chemical and structural properties, lignocellulosic biomass has shown great promise in becoming a potential alternative to carbon-based fuels. The heterogeneous nature of the biomass produces numerous sustainable chemical fuels and resources when thermally degraded. To better understand and optimize these processes, mathematical modeling of microstructural changes, induced by pyrolysis, is the focus of this work. Although similar, pyrolysis research has been conducted over the years, most of these approaches have been continuum-based. Typically, such methods are effective when analyzing macrostructural changes. However, continuum-based approaches become less effective when studying changes in the microstructure of biomass. This work utilizes discrete element method (DEM) as an alternative platform to simulate pyrolysis-induced changes. A DEM-based approach allows individual particles within a cross-section of biomass microstructure to be tracked and analyzed.

Undergraduate

*MOLECULAR DYNAMICS SIMULATION ON ORIGINAL AND POLYMER MODIFIED ASPHALT MIXTURES

Primary Author: George Rucker, Chemical Engineering

Advisor(s): Liqun Zhang

Asphalt is complicated viscous liquid originally coming from crude oil distillation. It is widely applied on road pavement and roof patching. In order to improve its performance on road pavement, different modifiers such as polymers have been applied to improve its physical and mechanical properties at different temperatures. In order to study the polymer modification effect on asphalt in molecular detail, 4 kinds of polymer modified model asphalt mixtures were built, each with 1 kind of polymer, including polystyrene, polyethylene, polystyrene-butadiene, and poly(styrene-butadiene-styrene). Based on all-atom LAMMPS molecular dynamics simulation trajectories, different physical properties including heat capacity, isothermal compressibility, expansion coefficient, diffusion coefficients of components, radial distribution function of components, and density were calculated on both polymer modified asphalt mixtures and original asphalt mixture. It was found that the diffusion coefficients, isothermal compressibility, expansion coefficient, and the heat capacity of the overall mixture at different temperatures

were not affected significantly by the addition of the modifier. However, the model asphalt density increases with the addition of the polymer except polyethylene. The distribution of molecules in mixture system changed during the simulation. This research helped to predict the modification effect of different polymers on the physical properties of asphalt mixtures and can help to design optimum asphalt mixtures on road pavement.

Undergraduate

*THE DECONTAMINATION OF WATER USING ADVANCED OXIDATION AND PULSED CORONA DISCHARGE

Primary Author: Maria Villasana Gonzalez, Chemical Engineering

Advisor(s): Pedro Arce

Water has always been seen as a renewable resource; however, as the human race keeps growing, water pollution has become a problem due to its constraints on resources. The goal for this research project is to find a more efficient and effective way of decontaminating water of natural and manmade pollutants. The Renaissance Foundry Method is a schematic designed to change how students learn based on innovation and trial and error; it consists of two main segments: the Knowledge Acquisition and the Knowledge Transfer. Along with the Renaissance Foundry Model the first segment of this project is knowledge acquisition, in which data and information on pulsed corona discharge, advanced oxidation, and electrostatic phenomena is collected. Advanced oxidation is a chemical process used to break down large particles in water to be decontaminated; there are two methods to accomplish this, with photocatalysis or electrocatalysis, which uses light or electricity as a catalyst respectively, the focus of this project is the latter. A form of electrocatalysis is the pulsed corona discharge; this device creates a difference in voltage throughout the system which creates a spark, or corona, and can deteriorate large particles in water. Continuing with the Renaissance Foundry Model, the project will evolve into the modelling of the efficiency of pulsed corona discharge as a decontamination method; ultimately, this study can provide the human race with new ways to better decontaminate water.

Department of Civil and Environmental Engineering

Engineering

Civil and Environmental Engineering

Graduate

*EARLY AGE PROPERTIES OF ZEOLITE CEMENTITIOUS MATERIALS

Primary Author: Md Shariful Islam, Engineering (Ph.D.)

Advisor(s): Benjamin J. Mohr

The cement industry is recognized as being responsible for a large amount of CO2 emission during the production of portland cement. In order to minimize CO2 emissions by limiting the use of cement, natural pozzolans may be a sustainable solution for making concrete. One such natural pozzolan is alumina-silicate based clinoptilolite type of natural zeolite. It has three dimensional crystalline frame structures with extremely small pores having alkali and alkaline earth cations. In the present research, application of natural zeolite as a supplementary cementitious material for producing durable concrete has been investigated. In this respect, clinoptilolite zeolite with very high purity (97%) replaced portland cement at 0, 5, 10, 15, and 20% by

mass. Setting time, workability, as well as heat of hydration of paste via isothermal calorimetry was conducted to assess the effects on early age properties. Research results revealed that replacement of zeolite increase the demand for water in the fresh mixture, although this situation can be overcome by adding low amount of high range water reducing admixture without any segregation. Research results also shown that zeolite accelerates the setting time due to the nucleation effect of C-S-H precipitation. Additionally, replacement of portland cement with zeolite can produce lower heat of hydration in the cementitious paste due to adsorption of water by its grain along with slow dissolution process of the fresh mixture. However, from practical point view, incorporation of 15% natural zeolite was found as an appropriate option for improving the early age properties.
Engineering

Civil and Environmental Engineering

Graduate

*UNSATURATED SOIL MODEL EFFECTS ON THE PROPAGATION OF THE SATURATED ZONE IN LEVEES DURING FLOODING

Primary Author: Prince Turkson, Civil Engineering

Co-Author(s)/Collaborators: Elizabeth Boeglin

Advisor(s): Daniel VandenBerge

Design of waterside slopes for rapid drawdown typically assumes an initial state of steady seepage prior to drawdown. However, levees built from low permeability soils are unlikely to reach this state during a flood, and a method has been developed to evaluate the degree of seepage propagation based on a linear approximation of the phreatic surface at end of flooding. For impervious foundation conditions, the degree of seepage propagation can be related to a time factor that is a function of the flood hydrograph, the soil coefficient of compressibility, and levee geometry. In addition, the post-flood saturated zone in levees depends on the soil water characteristic curve (SWCC) and hydraulic conductivity function (HCF), which are quite uncertain for unsaturated soils. This study parametrically compares results obtained using the Slide v. 8.0 Simple model to the Fredlund and Xing, and van Genuchten models for SWCC and HCF for levees with different flood, geometric and soil properties. The results show that the type of SWCC and HCF model selected has a significant effect on the predicted degree of seepage propagation, or the start-of-drawdown phreatic surface. For the same set of levee scenarios, the Simple model predicts significantly larger saturated zones within levees compared to those predicted using the Fredlund and Xing, and van Genuchten models. For more realistic assessment of levee seepage, van Genuchten is recommended. However, for cases where unsaturated soil properties are unknown or very uncertain, the Simple model may be appropriate.
Engineering

Civil and Environmental Engineering

Undergraduate

*DATA COLLECTION TOWARDS UNDERSTANDING STORMWATER MANAGEMENT AND FLOODING ISSUES IN THE TOWN OF GAINESBORO, JACKSON COUNTY, TN

Primary Author: Maci Arms, Civil Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Kalei Hair

Advisor(s): Tania Datta

The Town of Gainesboro of Jackson County, Tennessee has recently experienced significant flooding and stormwater

management issues. Located in an economically distressed county, it does not have the resources necessary to determine the cause of the issues. Speculated causes include the age and condition of the Town's stormwater management infrastructure, overgrown vegetation present in Doe Creek, a stream that drains much of the runoff from Gainesboro, and increased runoff due to land use change in the draining locations since 2010. However, prior to this project, limited data was available to determine the factors contributing to flooding. Therefore, this project aimed to collect data to provide a true understanding of the problem and hopefully lead to a more effective solution. In order to achieve this objective, information was gathered concerning: historic weather data, historic land-use data, topographical information, soil data, data on Doe Creek and its tributaries, water quality data, flood maps, storm drain and sewer maps with details on invert elevation and sizes, and socio-demographic data. Overall, none of the speculated causes were proven. The speculated cause of the Town's poor stormwater management infrastructure was identified as a data gap and is to be resolved in the future steps of this project.

Department of Computer Science

Graduate

*TOWARDS STANDARDIZATION OF IOT MESSAGE EXCHANGE FOR INTRUSION DATA SHARING IN HETEROGENEOUS ENVIRONMENTS

Primary Author: Gustavo Angeles, Computer Science (M.S.)

Advisor(s): Ambareen Siraj

The necessities of modern day lives today depend heavily on usage of Internet of Things (IoT). Exponential growth of this technology has led to increase in security and privacy concerns. Heterogeneity of the IoT Sensors is a major limitation for security decision makers who have to extract and integrate data from different IoT sensors to assess overall security posture of the network. Current security solutions cater to homogeneous networks where devices use similar configurations and protocols for communication. The heterogeneous nature of IoT demands a unified solution where IoT sensors can communicate with standard protocols and enable decision makers to naturally integrate and analyze data coming from various diverse sources. This work designs and implements a standard Message Exchange Protocol for IoT called IoTMEF. In this regard, we have designed and developed a heterogeneous IoT testbed based on a smart home scenario. It is completely customizable and usable for security research in the IoT space.

Graduate

*ASSESSING MODALITY SELECTION HEURISTICS TO IMPROVE MULTIMODAL DEEP LEARNING FOR MALWARE DETECTION

Primary Author: Farzana Ahamed Bhuiyan, Computer Science

Co-Author(s)/Collaborators: Katherine Brown; Md Bulbul Sharif

Advisor(s): Douglas Talbert

With the growing use of Android devices, security threats are also increasing. While there are some existing malware detection methods, cybercriminals continue to develop ways to evade these security mechanisms. Thus, malware detection systems also need to evolve to meet this

challenge. This work is a step towards achieving that goal. Malware detection methods need as much information as possible about the potential malware, and a multimodal approach can help in this regard by combining different aspects of an Android application. Using multimodal deep learning, it is possible to automatically learn a hierarchical representation for each modality and to give more weights to the more reliable modalities. Multiple modalities can improve classification by providing complementary information, however, the use of all available modalities does not necessarily maximize performance. Multimodal machine learning could benefit from a mechanism to guide the selection of modalities to include in a multimodal model. This work uses a malware detection problem to compare multiple heuristics for this selection process. We have used three different heuristics approaches for selecting the modalities at each step - the maxDifference heuristic, the maxSimilarity heuristic, and the maxAccuracy heuristic. Our experiments show that selecting modalities with low predictive correlation works better than the other examined heuristics. Our result suggest we do not need to combine highly accurate unimodal models, but rather we need models that make different kinds of errors. This method is designed to improve the stability and accuracy of our malware detection algorithms while reducing the overall cost.

Graduate

*UNCERTAINTY QUANTIFICATION IN MULTIMODAL ENSEMBLES OF DEEP LEARNERS

Primary Author: Katherine Brown, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Farzana Bhuyian

Advisor(s): Douglas Talbert

Uncertainty quantification in deep learning is an active area of research that examines two primary types of uncertainty in deep learning: epistemic uncertainty and aleatoric uncertainty. Epistemic uncertainty is caused by not having enough data to adequately learn. This creates volatility in the parameters and predictions and causes uncertainty. High epistemic uncertainty can indicate that the model's prediction is based on a pattern with which it is not familiar. Aleatoric uncertainty measures the uncertainty due to noise in the data. Two additional active areas of research are multimodal learning and malware analysis. Multimodal learning takes into consideration distinct expressions of features such as different representations (e.g., audio and visual data) or different sampling techniques. Multimodal learning has recently been used in malware analysis to combine multiple types of features. In this work, we present and analyze a novel technique to measure epistemic uncertainty from deep ensembles of modalities. Our results suggest that deep ensembles of modalities provide higher accuracy and lower uncertainty that the constituent single modalities and than the comparable hierarchical multimodal deep learner.

Graduate

*PROPAGATION OF INSECURE CODING IN CONFIGURATION SCRIPTS

Primary Author: Jonathan Dean, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Oluwatola Tofade; Sushil Poudel

Advisor(s): Akond Rahman

Infrastructure as code (IaC) is the practice of automatically managing configurations following the recommended software development practices. With the rise of cloud computing and automation, IaC tools, such as, Ansible are becoming increasingly popular amongst practitioners. Despite the popularity of IaC tools, insecure coding patterns (ICPs), such as hard-coded passwords, can

be unintentionally introduced into IaC scripts, which eventually can propagate across other repositories with IaC scripts. In our research, we investigate if ICPs in IaC scripts are propagated from one repository to multiple repositories in the open source software (OSS) ecosystem. We use a tool called Security Linter for Infrastructure as Code (SLIC) to analyze and identify ICPs in repositories that are cloned from other repositories. We compare the resulting output from the SLIC tool to determine the propagation of ICPs for IaC scripts in OSS. We use graph theory to determine if ICPs have propagated from one repository to other repositories. Based on preliminary findings we recommend practitioners take the utmost security consideration for ICPs in IaC scripts as they can propagate from one repository to another, creating large-scale propagation of ICPs in the OSS IaC ecosystem.

Graduate

*DARK VENDOR PROFILNG

Primary Author: Susan Jeziorowski, Computer Science (M.S.)

Advisor(s): Ambareen Siraj

Tor hidden services and anonymity tools alike provide an avenue for cyber criminals to conduct illegal activities online without fear of consequences. In particular, dark marketplaces are hidden services that enable the trade of paraphernalia such as drugs, weapons, malware, counterfeit identities, and pornography among other items of criminal nature. Several effective Dark Web analysis techniques have been proposed for Dark Web Forums and primarily focus on authorship analysis where the goal is one of two tasks: (a) user attribution, where a user is profiled and identified given an artifact they own, and (b) alias attribution, where pairs of users are identified to belong to the same individual. While these techniques may support dark web investigations and help to identify and locate perpetrators, existing automated techniques are predominately forum-based and stylometry-based, leaving non-textual artifacts, such as images, out of consideration due to the illicit nature of dark marketplace listings. Thus, new methodologies for adequate evidence collection and image handling in dark marketplaces are in demand. In this research, we collect stylometric, image, and attribute-based artifacts from 25 dark marketplaces and propose a machine learning based Dark Vendor Profiling methodology to achieve vendor attribution and alias attribution across dark marketplaces, thereby supporting investigative efforts in deanonymizing cyber criminals acting on the anonymous web.

Graduate

*LAKE STORAGE OBSERVATION BY CITIZEN AND SATELLITE

Primary Author: Debolina Halder Lina, Computer Science

Co-Author(s)/Collaborators: Dipayan Banik; Sheikh Ghafoor, Tennessee Tech University

Advisor(s): Sheikh Ghafoor

The storage and transport of water in rivers, lakes, and wetlands are key components of the global water cycle and the primary source of water resources in much of the world. However, no repository of lake level or storage exists, except for some large lakes. Of the millions of lakes worldwide, very few are monitored. Lake science would benefit from access to more data. In this research project, we have installed 73 staff gauges in 67 lakes in USA, France, and Bangladesh. We have developed a software system that allows everyday citizen to report lake heights via text message that are stored in database. To date over 1,100 individuals have submitted over 5,062 measurements. We have computed lake area from satellite images and combined with height measurements to compute lake storage variation. Validation with high precision Levellogger shows that citizen scientists' measurements

are 99% accurate. Our investigation so far indicates that citizens can accurately measure lake stages and these measurements can be combined with satellite data. Our future work includes increasing the gauge network, effectively disseminating the collected data and the derived knowledge to scientific community and citizen, answering what processes and factors impacts lake storage variations, and expanding the functionality of the software system.

Graduate

*DETECTING BIAS IN NEWS ARTICLE CONTENT WITH MACHINE LEARNING

Primary Author: Nathan Martindale, Computer Science (M.S.)

Advisor(s): Douglas Talbert

The internet and its various social media platforms allow for the rapid spread of information. While this has a number of benefits for society, it can also facilitate the proliferation of misinformation. Especially in recent years, concerns have been raised over fake news, factually incorrect claims, and biased news articles, regarding the potential impact on society and resulting polarization. The fields of machine learning and natural language processing contain building blocks and tools with the potential to help address some of these issues. We explore the application of weak supervision of machine learning models to predict the bias and reliability of news articles based on their content. Training models under the assumption that all articles share the bias and reliability labels of the source of the articles, we test their capability to generalize to a more realistic set of individually labeled articles.

Graduate

*ANALYZING CNN BASED BEHAVIOURAL MALWARE DETECTION TECHNIQUES ON CLOUD IAAS

Primary Author: Andrew McDole, Computer Science (M.S.)

Co-Author(s)/Collaborators: Maanak Gupta, Tennessee Technological University, Cookeville, TN, USA; Mahmoud Mahmoud, Manhattan College, Riverdale, NY, USA; Sudip Mittal, North Carolina at Wilmington, NC, USA

Advisor(s): Maanak Gupta

Cloud Infrastructure as a Service (IaaS) is vulnerable to malware due to its exposure to external adversaries, making it a lucrative attack vector for malicious actors. A datacenter infected with malware can cause data loss and/or major disruptions to service for its users. This paper analyzes and compares various Convolutional Neural Networks (CNNs) for online detection of malware in cloud IaaS. The detection is performed based on behavioural data using process level performance metrics including cpu usage, memory usage, disk usage etc. We have used the state of the art DenseNets and ResNets in effectively detecting malware in online cloud system. These CNNs are designed to extract features from data gathered from live malware running on a real cloud environment. Experiments are performed on OpenStack (a cloud IaaS software) testbed designed to replicate a typical 3-tier web architecture. Comparative analysis is performed for different CNN models.

Graduate

*USE CASE OF COUNTERFACTUAL EXAMPLES: DATA AUGMENTATION

Primary Author: Md Golam Moula Mehedi Hasan, Engineering (Ph.D.)

Advisor(s): Douglas Talbert

Counterfactual explanations are gaining popularity as a way of explaining machine learning models.

Counterfactual examples are generally created to interpret the decision of a model. In this case, if a model makes a certain decision for an instance, the counterfactual examples of that instance reverse the decision of the model. The counterfactual examples can be created by craftily changing particular feature values of the instance. In this work, we explore other potential application areas of utilizing counterfactual examples other than model explanation. We are particularly interested in exploring whether counterfactual examples can be a good candidate for data augmentation. At the same time, we look for ways of validating the generated counterfactual examples.

Graduate

*SNAPSKETCH: GRAPH REPRESENTATION APPROACH FOR ANOMALY DETECTION IN GRAPH STREAM

Primary Author: Ramesh Paudel, Computer Science

Advisor(s): William Eberle

A novel unsupervised graph representation approach in a graph stream called SNAPSKETCH for anomaly detection is proposed. It first performs a fixed-length random walk from each node in a network and constructs n-shingles from a walk path. The top discriminative n-shingles identified using a frequency measure are projected into a dimensional projection vector chosen uniformly at random. Finally, a network is sketched into a low-dimensional sketch vector using a simplified hashing of projection vector and the cost of shingles. Using the learned sketch vector, anomaly detection is done using the state-of-the-art anomaly detection approach called RRCF [1]. SNAPSKETCHhas several advantages: Fully unsupervised learning, Constant memory space usage, Entire-graph embedding, and Real-time anomaly detection.

Graduate

MOVING-TARGET DEFENSE FOR MODBUS NETWORKS

Primary Author: Sushil Poudel, Computer Science

Co-Author(s)/Collaborators: Emre Karagoz

Advisor(s): Denis Ulybyshev

Industrial Control Systems (ICS) are widely used in critical infrastructures such as nuclear power plants, power grids, water purification systems and more. ICS Modbus® network communication protocol was created without encryption and authentication features. Addresses of Modbus® devices are static, which opens an attack vector for an adversary, who aims to send malicious commands to Modbus® devices. As many ICS networks use static addressing schemes and the number of available addresses is significantly lower, a malicious outsider can infest and attack the ICS network. In addition, many ICSs were designed and deployed without a secure authentication and encryption for low-level sensor devices. In order to provide protection for Modbus® communication networks, we propose a Moving Target Defense (MTD) for Modbus® networks. The addresses of Modbus® devices are changed either on a pre-determined schedule or after a suspicious network activity has been detected by monitoring the traffic analysis. MTD intends to complicate things for the attackers by changing the addresses so that they miss their targets. To ensure synchronicity and protection from malicious outsiders, communicating network nodes must be able to change the address based on the time stamp. Our method for MTD implementation ensures the synchronicity of the address change in the ICS.

Graduate

*FUZZING TO IDENTIFY UNDISCOVERED BUGS IN SCIENTIFIC SOFTWARE

Primary Author: Raunak Shakya, Computer Science (M.S.)

Co-Author(s)/Collaborators: Jonathan Gibson; John Brackins; Akond Rahman, Tennessee Technological University

Advisor(s): Akond Rahman

Scientific software is defined as software that aids in research, testing or design of scientific models that are used to explain and predict the behavior of real objects or systems in a variety of scientific disciplines. Bugs in scientific software can cause large-scale consequences, for example, error-prone scientific results can lead to ineffectual projects and embarrassing retractions, incorrect financial transactions can cause tremendous monetary loss, etc. However, scientific software is typically developed by novices who are not well-equipped with bug finding tools. In this research, we investigate methods to systematically find undiscovered bugs in scientific software packages written in Julia. Julia is a programming language designed specifically for scientific and numeric computing. The goal of our research is to help scientific software developers find undiscovered bugs using fuzzing. Fuzzing is defined as a software testing technique which incorporates automated random input generation and injection to a software in the hopes of triggering an error condition or fault. We investigate 20 open-source Julia repositories collected from GitHub and apply fuzzing on these repositories. We have developed fuzzers in Python for four programs and have done some preliminary analysis on the documented crash reports. We find that there are several unhandled exception conditions in them, for example, we found 5 bugs in the Julia FFTW package, and 4 bugs in the Julia HTTP package.

Graduate

*YOUTUBE FOR SOFTWARE SECURITY?: YOUTUBE VIDEOS PROVIDE POINTERS FOR MICROSERVICE SECURITY

Primary Author: Md Shazibul Islam Shamim, Computer Science (M.S.)

Co-Author(s)/Collaborators: Akond Rahman, Tennessee Tech University

Advisor(s): Akond Rahman

Microservice applications are defined as software applications, which include services that interact with one another but failure of one service does not impact the execution of another. Microservice oriented design has become a popular software application design paradigm among software companies, such as Uber, Netflix, and Amazon as well as small startup companies due to delivery speed, reliability and greater flexibility. However, any insecure coding pattern in the code while developing microservice applications can make the entire system vulnerable to hackers. The goal of the abstract is to help software developers in building secure microservice applications. We have conducted a qualitative analysis of 6 youtube videos on microservice design antipatterns and an empirical study on open source microservice repositories. We have observed insecure coding patterns in those microservice repositories. We have defined 9 categories each with an associated pattern namely HTTP without TLS, authentication vs authorization, hard coded secret, weak encryption algorithm, use of default ports, violation of least privilege principle, insufficient logging, poor orchestration layer configuration, API service sharing and distributed deadlock. We advocate for future research that will create a taxonomy of insecure coding patterns so that developers can find and resolve insecure coding patterns during code review.

Graduate

*DETECTING DOMAIN GENERATING ALGORITHM BASED MALICIOUS DOMAINS USING BIGRAM

AND WORD2VEC MODEL

Primary Author: Steven Smith, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Md Ahsan Ayub; Paul Tinker, Science Applications International Corporation (SAIC)

Advisor(s): Ambareen Siraj

Domain Generating Algorithms (DGAs) are used to facilitate server communication for various types of cyber-attacks, primarily botnets. These algorithms are used to evade defensive methods to block malicious communication such as blacklisting. Using DGAs allows botmasters and malware owners to easily communicate with their victim machines to facilitate attacks without the fear of their command and control (C&C) server. Attackers can predominantly change the domain used for their C&C server from one to another in short time intervals as DGA has got tremendous capability of generating millions of pseudo-random domains. Network administrators find it difficult to detect DGA through network logs due to the flood of DNS queries for non-existent domains (NXDomain). Therefore, automatic detection of DGA created domains is a critical countermeasure to prevent associated malicious botnet communication. In our research, we propose a comprehensive solution to detect such DGA-based domains used in malware communication. Two distinct feature extraction methods, the Bigram model and the Word2Vec model, are applied for text processing. We apply machine learning and deep learning techniques on the largest reported dataset of 84 different traditional and dictionary-based DGA. Our results demonstrate exceptional success in both binary classification, classifying a given domain as benign or malicious, and multi-class classification, identifying the specific malware family that produced a domain.

Graduate

*USE OF ADVERSARIAL MACHINE LEARNING FOR AVOIDING OCCUPANCY DETECTION FROM SMART METER

Primary Author: Ibrahim Yilmaz, Computer Science

Advisor(s): Ambareen Siraj

More and more conventional electromechanical meters are being replaced with smart meters because of their substantial benefits, such as providing faster bi-directional communication between utility services and end users, enabling direct load control for demand response, energy saving and so on. However, the fine-grained usage data provided by the smart meters raises additional security and privacy concerns for users and companies. Occupancy detection is one such example which causes privacy violation of smart meter users. Detecting the occupancy of a home is straightforward with the time of use information as there is a strong correlation between occupancy and electricity usage. However, most of the existing privacy preserving solutions use crypto-graphical techniques that are computationally expensive for resource restrained smart meters. In this work, our major contributions are twofold. First, we validate the viability of an occupancy detection attack based on a machine learning technique called the Long Short Term Memory (LSTM) method and demonstrate improved results. In addition, we introduce an Adversarial Machine Occupancy Detection Avoidance (AMODA) framework as a counter attack in order to prevent abuse of energy consumption. Essentially, the proposed privacy-preserving framework is designed to mask the real-time or near real-time electricity usage information using calculated optimum noise without compromising the users' billing systems functionality. Our results show that the proposed privacy-aware billing technique upholds users' privacy strongly.

Undergraduate

*POKÉMON CLASSIFICATION: ATTEMPTING TO DETERMINE LEGENDARY STATUS VIA QUANTIFIABLE CHARACTERISTICS

Primary Author: Elias Brady, Computer Science

Co-Author(s)/Collaborators: Jonah White; Andrew Hall; Riley Smith

Advisor(s): William Eberle

Originally released in February of 1996, Pokémon has been around for 24 years and has gone through multiple games or generations. Each generation produces many new Pokémons, with a set number of legendary Pokémons that are considered rare and very powerful. Our project aims to determine what makes a Pokémon legendary and accurately predict whether a given Pokémon is legendary or not. We will be using the complete Pokémon data-set produced by Rounak Banik on Kaggle, consisting of 802 different Pokémons and 41 different attributes about each Pokémon such as type, attack, and defense. Our plan is to analyze the known Legendary Pokémon, and then define and predict what makes a Pokémon legendary, with a predictive accuracy of at least 90%.

Undergraduate

*DETECTING ILLEGITIMATE USE OF LEGITIMATE CREDENTIALS

Primary Author: Austin Brown, Computer Science

Co-Author(s)/Collaborators: Kendall Land; Andy Brown

Advisor(s): Maanak Gupta

Any organization with sensitive, valuable, or critical data, or direct access to such data, is at risk of being attacked by cyber criminals who steal and use legitimate credentials for a multitude of purposes. This poses one of the highest threats to critical, sensitive, or even classified information for an organization. If a nefarious actor is able to access a network with legitimate credentials there are currently very limited ways to detect the malice of the activity.

By establishing a per-user behavior profile, we aim to apply machine learning anomaly detection algorithms to determine when a user account's activity indicates that it has been compromised by an attacker with stolen credentials. In this way, we will map a user's normal activity to a high dimensional space to predict what the user is likely to do and when. Within a threshold, deviation from this prediction indicates that an action may need to be taken to verify this user's identity.

Our data set is a sample of mixed enterprise logs from Los Alamos National Laboratory covering three months of authentication, network flow, process history, and DNS service. Some of the log items represent offensive red-team exercises, and we propose a system to identify these events based on their dissimilarity from regular user behavior.

Undergraduate

*PRESENTING STUDENTS WITH BUFFER OVERFLOW VULNERABILITY

Primary Author: Glen Cathey, Computer Science

Co-Author(s)/Collaborators: Emre Karagoz

Advisor(s): Denis Ulybyshev

The goal of this project is to analyze how students can apply and adapt low level computer science principles, specifically in exploiting buffer overflows in Linux operating system. Students are given an executable file with a known buffer overflow vulnerability, and a source code file with a known vulnerability. Each student must

examine the memory addresses of their executable in order to calculate a payload, which will overwrite the return address in stack and will jump in a “secret” function. Each student is provided with a compiled binary executable file with a minor change of the displayed message. Once students have successfully demonstrated the buffer overflow exploit, they will need to find a protection mechanism against the buffer overflow attack they just developed. The way that students approach the problem of attacking software, as well as their strategies regarding to protect against buffer overflow attacks, will be studied in order to evaluate students’ active learning skills.

Undergraduate

*PROTECTION AGAINST CROSS-SITE SCRIPTING ATTACKS

Primary Author: Julianne Cox, Computer Science

Advisor(s): Denis Ulybyshev

The use of web browser cookies has become quite prevalent online. Cookies follow internet users everywhere they go, whether to keep them logged in to certain services or to personalize the advertisements they receive. Since these cookies can contain sensitive information like usernames and passwords, it is of utmost importance that they are protected from any malicious activity. One common way to steal a user's cookie is through Cross-Site Scripting (XSS) attacks, where malicious scripts are injected into text comments on websites, such as forum discussion boards, that allow users to submit text messages and comments. These malicious scripts, injected into text, may deliver web browser cookies to the attacker without making the user aware of the hostile action taking place. To combat these attacks, we are proposing easily implementable solutions for those who host websites that allow users to submit text messages and comments. To analyze the proposed solutions, we have created two versions of the same website to portray the difference in XSS attacks on protected versus unprotected websites.

Undergraduate

*NLP DISASTER TWEETS CLASSIFICATION

Primary Author: Kristopher Flint, Computer Science

Co-Author(s)/Collaborators: Zachary Kellerman

Advisor(s): William Eberle

In this research, we use natural language processing to predict whether or not text is referring to a natural disaster. Using the Kaggle competition data, consisting of 10,000 labeled Tweets, we apply machine learning models to determine which Tweets are about real disasters and which ones are not. We first perform some exploratory data analysis, visualizing the dataset, and then text preprocessing to remove irrelevant characters. We discover that most disasters are related to natural disasters and criminal activity, while non-disasters, focus on slang and YouTube videos. We implement five machine learning models: Naive Bayes, Support Vector Machines, Random Forest, a Neural Network, and an Ensemble Learner. Naive Bayes and the Ensemble Learner appear to have slightly more success than the other models as the accuracy for these is about 80%. Finally, we tune the model parameters so as to increase the performance of our predictions.

Undergraduate

*CARIBBEAN DELPHINIDAE CLICK CLASSIFICATIONS

Primary Author: Melissa Grier, Computer Science

Co-Author(s)/Collaborators: Kristen Forte; Dylan Bush; Jarod Teague

Advisor(s): William Eberle

This research focuses on identifying animals of the Delphinidae family found in the Caribbean by analyzing acoustic signals. Delphinids produce large numbers of acoustic signals identified as echolocation clicks which provides a useful classification system. Recent studies have established that the fundamental frequency of the majority of whistles used for social communications covers the frequency range of 2–35 kHz and up to 100 kHz for the harmonic frequencies. The challenge in click classification results from recognizing patterns among many sources of variability. Our findings will be presented by figures of network relationships between clicks and a detailed exploratory analysis to highlight clusters and subsets of training and test data along
with clustering algorithms.

Undergraduate

*DETERMINING JOKE RATINGS USING DATA SCIENCE METHODS

Primary Author: Rudy Guinac, Computer Science

Co-Author(s)/Collaborators: Chris Swindell; Nick Hatfield; Carlos Mata

Advisor(s): William Eberle

Jokes are an inherently subjective form of entertainment, a joke one person finds comical could just as easily be seen as dull by someone else. This subjective form of entertainment presents both a fun challenge and interesting question: Is it possible to accurately rate jokes using data science tools and algorithms? Two goals must be met in order to satisfactorily answer this question: 1.) Determine first whether a joke is good or bad (having a positive or negative score), and 2.) Determine what the average rating of a joke would be on a 20 point scale (from -10 to 10). Using data obtained from the data science competition website https://datahack.analyticsvidhya.com/, we will present and describe the various methods we used to attempt to answer this question using data analysis techniques in both R using the RStudio IDE (Interactive Development Environment) and Microsoft Excel. We will also present our findings in trying to answer whether a subjective topic such as joke ratings can be determined to some degree of success using a more objective methodology.

Undergraduate

*IDENTIFYING TRANSMISSION AND RISK FACTORS FOR COVID-19

Primary Author: Brittany Harbison, Computer Science

Co-Author(s)/Collaborators: Eric Cabarlo; Logan Capes, Dustin Lee

Advisor(s): William Eberle

Over the past few months, the rise of a novel coronavirus (COVID-19) has taken the world by storm. The virus has spread rapidly throughout many world communities, leading to its current classification as a pandemic. Many researchers have already published insights and observations on the disease to shed light on this new adversary, while additional research is still ongoing. The US government and medical professionals recently called on the data science community to reveal insights into this virus through the COVID-19 Open Research Dataset (CORD-19), a massive collection of coronavirus-related research. Contained within CORD-19 are insights into risk factors and transmission behavior for COVID-19.

This work assembles sections of CORD-19 data into an easily-readable format and uses this output to answer specific questions about the disease, such as environmental factors that correlate with increased transmission and other factors of risk that may contribute towards an individual

patient contracting the virus. Additionally, the findings unveiled by this approach are further validated using machine learning algorithms on auxiliary datasets gathered from a few countries impacted by the virus.

Undergraduate

*RECOMMENDATION ENGINE

Primary Author: Trevor Judd, Computer Science

Co-Author(s)/Collaborators: Maria McConkey; Kristen Patterson

Advisor(s): William Eberle

Online judge platforms for programming problems need an effective recommendation engine to be able to recommend new engaging and challenging problems to the users. However, it is difficult for online judges to determine how challenging a new problem will be to each user. Recommending problems that are not challenging enough will make a user become unengaged. Recommending problems that are too challenging will make a user want to give up. A good determining factor for recommendations is the number of attempts a programmer at different expertise makes. This recommendation engine uses statistical models which contain information about the problems, the user, and the user's submissions. The model predicts the number of attempts a user is likely to make when trying to solve problems of similar difficulty. To build these models, R will be used to analyze the data and produce visualizations. The data has been collected and separated into train (70% of the submissions) and test (30%) sets by Analytics Vidhya. It contains 221,850 submissions which comprises 3,571 users and 6,544 problems. To evaluate the model, the F1 score will be used. Based on the F1 scores of similar models that have been built for this issue, an F1 score of 0.4 has been deemed minimally acceptable for a model to address this issue. Producing an accurate model will help online judge platforms be able to engage and challenge their users and users be able to push the boundaries of their skills.

Undergraduate

MALWARE DETECTION USING RECURRENT NEURAL NETWORKS

Primary Author: Jeffrey Kimmell, Computer Science

Co-Author(s)/Collaborators: Sina Sontowski; Andrew McDole; Maanak Gupta, Tennessee Technological University

Advisor(s): Maanak Gupta

With the vast majority of services migrating to the Cloud, companies such as Microsoft and Amazon have begun to offer infrastructure for these services to operate on. The infrastructure offered by these companies, known as Cloud Infrastructure as a Service or IaaS, has become a large target for attackers thus making the security of these services a top priority. Malware placed on this infrastructure that goes undetected or is not detected fast enough could have far-reaching and costly consequences. This paper will analyze the effectiveness of various types of Recurrent Neural Networks (RNN) for detecting malware placed on Cloud IaaS. By analyzing performance metrics such as CPU, memory, and disk usage, our various RNN models can quickly and accurately detect malware. RNNs are a powerful tool for detecting malware due to their ability to model time-series data. This ability to analyze changes over time also presents the issue of how to shape the data so that it is properly represented in sequential order. We have been able to successfully shape our data and perform an experiment using a Long Short Term Memory (LSTM) method. Our goal is to run multiple experiments utilizing varying types of RNN to determine which method yields the highest and most accurate detection rate.

Undergraduate

*STOCK RETURN PREDICTION ALGORITHM

Primary Author: Austin Monroe, Computer Science

Co-Author(s)/Collaborators: Joel Wattlington; Chris Laycock; Logan Davis

Advisor(s): William Eberle

The stock market is ever changing and there is no certain way to predict which stocks will perform better than others.We plan to compile the stock data that is given to us by Challenge Data and develop an algorithm in order to predict how stocks will perform in the future. Many patterns can be seen in the data and our team plans to be able to predict, with a strong level of accuracy, the return of a stock based on the performance of that stock over a twenty day period.Our team will be using primarily R studio to perform our data analysis on this dataset. We plan to represent our data using many graphs showing the correlation between different stock parameters and the return. Using these graphs, we will be able to determine whether our hypotheses are correct and to what magnitude they impact the total return.

Undergraduate

*ATTRIBUTE ACCESS CONTROL IN WEB APPLICATIONS

Primary Author: Bradley Northern, Engineering Technology

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborators: Abhijeet Solanki; Braxton Westbrook; VadimKholodilo; Denis Ulybyshev, Tennessee Technological University

Advisor(s): Denis Ulybyshev

In modern web applications role-based access control (RBAC) is not enough to determine amount of information that can be accessed by users, due to current cybersecurity vulnerabilities. An additional security layer needs to be put into place, such as attribute access control (ABAC), which takes into consideration the web browser used, Type of Operating Systems, Network Security Protocols, and Authentication level.

We developed a solution for ABAC as a searchable set of stacked data structures, in C++17. Client's attributes, for example, Browser, Operating System, and Network is stored in a shared pointer array. Each element then contains a hash table of names of each attribute. For example, the browser element will contain names such as: Opera, Chrome, Firefox, or Edge. Then each of the positions of the first hash table, points to a secondary hash table, which contains supported versions and a trust rank level for the associated version. Hash tables were chosen as search, is O(1) at best case. Meanwhile traversing the array of hash tables is O(m), where 'm' is the number of elements in the array, we have implemented OpenMP sections. So that, a single thread searches for each set of client's attributes. This brings search and traversing theoretically closer to O(1), including parallel overhead. We believe this application of ABAC will be the framework of other applications, such as using Artificial Intelligence, and machine learning to determine user access of web applications.

Undergraduate

*PUBG PLACEMENT PREDICTION

Primary Author: Aaron Otto, Computer Science

Co-Author(s)/Collaborators: Trey Burks; Rustan Hoffman; Zechariah Crannigan

Advisor(s): William Eberle

Our research is a dive into how PUBG (an online Battle Royale video game) placements is related to player strategy and skill, or if the randomness in the game plays a larger role. This research is part of the PUBG Finish Placement Prediction competition. Using the data provided by the competition we use machine learning to determine what variables have the greatest effect on placement and in doing so, we hope to create a best strategy for players to use to improve their average placement.

Undergraduate

IMPLEMENTING DEEP-Q-NETWORKS WITH DROPOUT IN AN ATARI VIDEO GAME SPACE

Primary Author: Brendan Roberts, Computer Science

Advisor(s): Douglas Talbert

Video games are a difficult realm for deep learning to optimize, but they provide an excellent pre-built simulation environment. Even simple Atari games require highly multi-dimensional inputs, making them a challenge for reinforcement learning agents. Deep-Q-networks, or DQNs, are adept at learning from highly varied environments, including video games. Evaluating algorithms in this space provides an accessible, easy-to-implement, initial appraisal of their capability and flexibility to handle complex and high-dimensional inputs in more advanced, difficult-to-test domains. Using dropout during training and testing is an efficient way to model uncertainty within neural networks, without a prohibitive computational cost. In this work, we seek to combine these two techniques and analyze their performance, to see if incorporating uncertainty quantification into the learning process makes the agent more adept at handling the high-dimensional sensory inputs. To the best of our knowledge, this is the first examination of uncertainty quantification in the Atari video game space. To test this, we augment a successful implementation of the DQN algorithm in Python by adding a dropout-based Bayesian uncertainty approximation. We then evaluate this technique with a popular Python-based testbed.

Undergraduate

*PUMP IT UP DATA MINING

Primary Author: Adam Rucker, Computer Science

Co-Author(s)/Collaborators: Eric Contini; Tyler Fulghum; Matthew Brotherton

Advisor(s): William Eberle

The goal of the team is to create and visualize models for the Pump It Up: Data Mining the Water Table problem. The goal of this problem is given data on a pump system, be able to predict what status the pump currently is by accessing the information given and trying to find trends and patterns in the data that allow for predictions about the current status of the pump based on relevant information. The purpose of this problem is to use the known knowledge of the pumps to try and estimate the status of the pump ahead of time to know whether or not a technician is required. This will enable the technicians' resources to be more efficiently distributed to provide maintenance more accurately. This will allow for the pumps overhead to be reduced and pump downtime to also be lowered so that the people that rely on this water source have more reliable access to water. We will create models with visualizations to demonstrate the trends in the data and show a prediction for what the current status of a pump is and use known data to validate the accuracy of these models.

Undergraduate

*BRINGING SANITY TO MARCH MADNESS

Primary Author: Austin Tice, Computer Science

Co-Author(s)/Collaborators: Alex Marti; Kendall Land; Max Layer

Advisor(s): William Eberle

Every year come mid-March, the NCAA College Basketball tournaments start and mania promptly ensues. Games that should be blowouts become nail-biters, upsets happen, and a few underdog teams become what are known as “cinderellas”. All of which shows how it has earned the name March Madness®. Our team plans to address the problem of being able to predict the outcome of a game in the tournament. Our goal is to try and quantify and/or explain a team’s ability to “stay in a game”, their competitiveness, and their “cinderella-ness” based on how they performed in the regular season. Then, using the attributes we determine for each team, can we predict our overall goal of who will win each game in the tournament. We will be using the dataset provided by Kaggle, which includes data on how both Men’s and Women’s basketball teams performed and placed in tournaments in previous years. Our methodology will be strongly rooted in exploratory data analysis with a strong emphasis on clean, properly processed data to try and achieve the most accurate predictions from our machine learning models.

Department of Electrical and Computer Engineering

Graduate

*LAYERED DD COIL: AN IMPROVED COIL STRUCTURE FOR WIRELESS POWER TRANSFER

Primary Author: Muhammad Bima, Engineering (Ph.D.)

Advisor(s): Indranil Bhattacharya

Wireless power transfer is gaining application in electric vehicles and in the charging of biomedical implants. Inductance is a primary property that enables wireless power in an inductive wireless power transfer (IWPT) system. It indicates both the power storing and sharing capability of the coil involved.
The Double Dee (DD) coil is a coil type that has shown a significant amount of inductance for this purpose.
To increase the DD coil inductance, more turns and a much wider area are required. With an area constraint, this will limit the use of the DD coil. In this research, a Layered DD coil is presented to further enhance the inductance capability of the DD coil and overcoming the area constraint. Multiple layers of the coil are used and the coils are oriented such that the emanating magnetic field adds up constructively thereby enhancing the coil inductance. Simulation and experimental implementation of the coil have shown an enhanced and superior performance in comparison to the parent DD coil. The use of shielding materials will enhance its overall performance and prevent or reduce the potential hazard of the field. Various shielding materials known to have good magnetic properties were investigated to determine their effect on IWPT. Ferrite, Cobalt-Iron, Steel were among the materials used and which showed significant prospects in IWPT. It was deduced based on their performance that cobalt-iron would enable a higher amount of power to be transmitted than ferrite. Other configurations of the LDD coil show the potential for cost-saving.

Graduate

CAPACITIVE POWERED SENSOR NETWORK USING A SERIES TRANSMISSION LINE

Primary Author: Michael Coultis, Electrical and Computer Engineering (M.S.)

Co-Author(s)/Collaborators: Jonathan Dean; Charles VanNeste; Connard Murray

Advisor(s): Charles VanNeste

Sensors require power in order to operate and transmit data to a network. Sensors on a network often have individual batteries for each sensor node. Each battery needs to be recharged, and a nearby energy source (solar or DC source) may not be available. By using QWiC (Quasi-Wireless Capacitive) power transfer multiple sensors can be powered on the same transmission line with a stray capacitive ground return path. This could allow for a sensor network to be powered on a single conductive surface. Here, we will utilize a marx inverter capable of producing a standing wave ratio high enough to power a series device. We will evaluate the system efficiency and take quantitative measurements of key parameters that define performance.

Graduate

*EVS GRID INTEGRATION PERFORMANCE EVALUATION AND CONGESTION PREVENTION

Primary Author: Chikezie Emeghara, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Satish Mahajan

Advisor(s): Satish Mahajan

The ecosystem friendly and socio-economical merits of Electrical Vehicles (EVs) have enhanced its application globally. Although it is widely argued that EVs grid integration undermines power system security, reliability and upsurge electricity consumption, but the benefits in emission reduction is enormous, which conforms to the Asian Pacific Partnership on Clean Development and Climate agreement with US. However, the purpose of this study is to evaluate the impact of EVs on Medium Voltage (MV) distribution network: voltage stability and thermal overloading of transformers and cables on an IEEE 14-Bus system. The proposed method is a holistic approach in which the impact on the steady state operation of individual components (EV charger, load, transformers, buses, etc) of the system would be investigated for reliability. A load flow analysis would also be conducted on the network for power loss evaluation. However, the anticipated results of this study show that integration of large number of EVs to grid system increased line losses, transformer and cable overloading, and reduced system stability, hence, the needed for grid architecture compensation cannot be overemphasized. Therefore, the results after Bus compensation should show improved system stability, voltage profile, reduced thermal loading and congestion.

Graduate

*TUNING OF CENTER OF INERTIA BASED PI-LOAD-FREQUENCY-CONTROL USING OPTIMAL CONTROL AND ROOT LOCUS

Primary Author: Anusha Sai Gollapudi, Electrical and Computer Engineering (M.S.)

Advisor(s): Ghadir Radman

In Power Systems, inertia provided by the rotating parts of a synchronous machine, contributes significantly toward the stability of the system. Center of Inertia (CoI) frequency is defined as the weighted average of the

machines' frequency in a power system, weightings being the individual machine's inertia. The CoI frequency is used as a feedback input to the Automatic Load Frequency Control (ALFC) Loop.

Several authors used PI-controller for the ALFC loop with gains found by trial and error. Others used the PI-controllers with gains found using root-locus; finding proper pole location is the big challenge in this method. Several other authors used optimal control methodology; implementation of this control require application of state estimator, as complete state measurements are not available. Application of the combined optimal control and estimator degrades the performance of the system. This research employs Root Locus method. The PI-controller is tuned such that the resulting poles of the system are close to the dominant poles of the optimal control system.

A Standard 9-bus, 3-machine power system is used to show the effectiveness of the proposed controller. Stability of the system and machine stress under transient conditions with various controllers and without the controller are used for comparison. Software programs such as MATLAB, Power System Tool Box, and SIMULINK is used to analyze various transient conditions.

Graduate

*WORDA: A "6/3" WINOGRAD OFFLINE-RUNTIME DECOMPOSITION ALGORITHM FOR FASTER INFERENCE

Primary Author: Jacob Nelson, Electrical and Computer Engineering (M.S.)

Co-Author(s)/Collaborators: Tolulope Odetola; Syed Rafay Hasan, Tennessee Technological University

Advisor(s): Syed Rafay Hasan

Convolutional Neural Networks (CNNs) have demonstrated impressive performance in recent times and have shown a wide range of applicability. The deployment of CNNs on resource-constrained devices to achieve edge inference still proves challenging because of the computation, memory, energy, and bandwidth requirements of CNNs. To address these issues, FPGAs are typically used to implement CNNs due to their high flexibility and low power consumption. The Winograd convolution algorithm can be used to further reduce the computation requirements of a convolution operation. This work proposes a "6/3" Winograd Decomposition Convolution Algorithm that provides an efficient approach of performing a separated Offline-Runtime Winograd decomposition to achieve low latency with comparable hardware resources. The "6/3" WORDA uses transformation matrices with elements of powers of 2 or sums of powers of 2 to perform convolution between input image matrices and weight matrices. This allows for the usage of shift registers and adders instead of multipliers leading to a conservation of resources and lower latency. In this work, the "6/3" WORDA is used to design convolution layers for CNN accelerators for the CNNs LeNet and AlexNet using Vivado HLS (High Level Synthesis). The result shows a 58.3% decrease in latency while only incurring a constant increase in BRAMs, no change in DSPs, and a 122% increase in flip-flops (FFs) and lookup tables (LUTs) usage when using filters of size 5x5 when compared to state-of-the-art approaches.

Graduate

*DESIGN AND IMPLEMENTATION OF AN AUTONOMOUS WHEELCHAIR FOR PHYSICALLY CHALLENGED PEOPLE

Primary Author: Oluwatola Tofade, Electrical and Computer Engineering (M.S.)

Advisor(s): Ali Alouani

Many people struggle on a daily basis with the issue of mobility. For most, the struggle of mobility is due to a

physical handicap that is prohibiting their movement. Wheelchairs were invented to help provide a remedy for these situations. However, standard wheelchairs still seem to prove ineffective for a large percentage of users. This includes people with weak muscle, the blind, paraplegics, or those who were born with congenital amputation. With the advancement of technology, it is possible to make wheelchairs, "smart" and "safe" to allow people with disabilities to use such chair by simply communicating with them.

This research aims to deliver an automated, safe and convenient solution for assistive technologies/advanced smart assistance which will enable elderly and handicapped people with locomotive disabilities to travel around alone with no assistance. The command of the person in the form of voice, written information, or hand gesture, is captured by the wheel chair artificial brain and convert it to a control command, which tells the wheelchair where to go. In order for the artificial brain to perform properly, it must know the environment it is operating in and the coordinates of the different possible spots the chair is likely to go.

The research project is broken down into four stages, namely: a) Mapping of the environment b) Localization of the Wheelchair in the environment c) Autonomous Navigation and d) Human command Interpretation. In this phase of the research, the human voice is used to provide the locations to go to.

Undergraduate

*SECURING AUTOMOTIVE NETWORKS WITH VEHICLE-AGNOSTIC TECHNOLOGIES

Primary Author: Samuel Hollifield, Computer Engineering

Co-Author(s)/Collaborators: Robert Bridges, Oak Ridge National Laboratory; Miki Verma, Oak Ridge National Laboratory; Michael Iannacone, Oak Ridge National Laboratory

Advisor(s): Sheikh Ghafoor

Modern vehicles are incredibly complex and operate through an exchange of information between many Electronic Control Units (ECUs)—which are small embedded computers that can contain an array of sensors and inputs. These ECUs communicate through Controller Area Networks (CANs), a broadcast network with a lightweight protocol, which have been mandated for use in most vehicles since 2008. Previous research has shown that a vehicles CANs are critically vulnerable to exploitation: hackers can remotely execute code and collect potentially sensitive private information. Although numerous examples of intrusions and attacks have been demonstrated through research, the practical application of cybersecurity remains inconsistent across automotive manufacturers. Further, passenger vehicle manufacturers use propriety encodings for CAN messages, obfuscating the meaning of data. To help solve this critical issue, we present our research towards producing a vehicle-agnostic intrusion detection system. Our proposed solution is an after-market prototype which can plug in to an automotive on-board diagnostic port to monitor network traffic. The prototype uniquely configures itself per-vehicle and uses a suite of algorithms to determine the presence of a cyber-attack. Our research expands upon current CAN detection solutions by matching signals in the obfuscated network with known values generated from automotive diagnostic services.

Undergraduate

*ADAPTIVE STEP SIZE INCREMENTAL CONDUCTANCE BASED MAXIMUM POWER POINT TRACKING

Primary Author: Eungkyun Kim, Electrical Engineering

Advisor(s): Indranil Bhattacharya

Extracting maximum power available from a photovoltaic array requires operating at maximum power point (MPP),

which changes with multiple environmental factors, mainly temperature and irradiance. Because any practical PV system would be under a condition in which these factors change, the operating point of a PV array needs to be constantly updated to a new MPP. The process to identify the new MPP is called maximum power point tracking (MPPT). Traditionally, incremental conductance MPPT algorithm with fixed step size is used. This algorithm, however, suffers from a trade-off between convergence speed and accuracy. I propose an incremental conductance MPPT algorithm with variable step size, which adaptively changes step size after each iteration based on how far away the current operating point is from a new MPP. This is done by updating step size to a product of derivative of power with respect voltage and an exponential decaying function, which effectively increases step size as the operating point gets further from the MPP, and decreases step size as the operating point approaches the MPP. With this algorithm, the aforementioned trade-off can be dramatically mitigated as faster convergence speed can be achieved with little to no power loss. A series of simulations involving variation of temperature and irradiance were performed using MATLAB, and convergence speed and accuracy were compared with the traditional fixed step size algorithm.

Department of Manufacturing and Engineering Technology

Graduate

*WIRE +ARC ADDITIVE MANUFACTURING OF ALCOCRFENI HIGH ENTROPY ALLOY

Primary Author: Md Rumman Ul Ahsan, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Gi-Jeong Seo

Advisor(s): Duckbong Kim

Gas tungsten arc (GTA) based Wire+arc additive manufacturing (WAAM) can deposit any metallic material due to its inherent independent control of the arc. Additive manufacturing of high entropy alloys (HEAs) combines the extraordinary mechanical properties of the new family of alloys with flexibility with geometry and complexity of the process. In this work, a GTA-WAAM approach is presented for near-net-shaped deposition from a pre-alloyed and extruded AlCoCrFeNi HEA. The microstructure of the as-deposited HEA was investigated and compared with the arc melted HEA of the same composition. A strong influence of the high heat input followed by a rapid solidification along with a directional nature of cooling was observed on the amount of phases, their composition and spatial distribution were observed. It is concluded that GTA-WAAM can be a versatile tool for additive manufacturing with HEAs, despite the challenges involved to have a controlled microstructure.

Graduate

*DEVELOPMENT OF METHACRYLATE-BASED DENTURE REINFORCED WITH SHORT GLASS FIBERS USING THE FUSED FILAMENT FABRICATION PROCESS

Primary Author: Ankit Gupta, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Ismail Fidan; Dr. Frank Alifui-Segbaya, Lecturer/School of Dentistry and Oral Health/Griffith University

Advisor(s): Ismail Fidan

Fiber reinforced additive manufacturing (FRAM) offer opportunities that could be explored in the dental field concerned with the "design and manufacture" of devices. Herein, we assessed the viability of FRAM for fabricating complete denture bases: polymethylmethacrylate (PMMA) as matrix was reinforced with short glass fibers (SGFs) using the fused filament fabrication (FFF) process. Representative parts for this study, were built with different layer heights (0.2, 0.1, 0.05 mm) and volume fractions (0%, 2.5%, 5%), and analyzed for surface roughness (resolution) and mechanical properties (tensile, flexural, compressive properties and microhardness). Mechanical properties were influenced significantly by layer height and volume fractions; in general, parts with lower layer heights and SGFs reinforcement showed improved mechanical properties and good surface finish. Additional scanning electron microscopy assessed the effect of fiber distribution, fiber breakage, fiber accumulation and the adhesion at the interface of the PMMA/SGFs composite materials. The practical implications of the study at a "proof of concept stage" are potential low-cost manufacturing and affordable devices, patient comfort and improved clinical properties particularly for geriatric use.

Keywords: Fiber reinforced additive manufacturing, PMMA, Denture base, Composite material, layer height, surface resolution

Graduate

*MECHANICAL CHARACTERIZATION OF FUNCTIONALLY GRADED MATERIALS PRODUCED BY THE FUSED FILAMENT FABRICATION PROCESS

Primary Author: Seymur Hasanov, Mechanical Engineering

Advisor(s): Ismail Fidan

In this study, the design and fabrication workflow of functionally graded materials (FGMs) were introduced using the fused filament fabrication (FFF) process. The combination of three different polymers was mechanically characterized. All three combinations of materials showed approximately the same results in terms of tensile strength and Young's modulus values. Printing in the ZX direction showed poor strength values in comparison with other printing directions. Interface analysis with different transition patterns was accomplished and the advantage of gradient transition was achieved. Micrography of specimens was deeply analyzed to validate the test results. Statistical methods were applied to investigate the relationship between microstructural descriptors (volume fractions) and process-related parameters (printing temperatures). The results of the analysis of variance (ANOVA) has confirmed that printing temperature and concentration have a significant impact on tensile test results. The data-driven approach was employed to construct a linear regression model in order to formulate input data for finite element (FE) implementation. As a result of the FE simulation, effective Young's modulus was calculated with the help of MATLAB code. FE analysis was validated through experimental test results. The comparison of the numerical method and experimental values showed less than 5% error for FGM specimens in 250, 260 and 270 0C printing temperatures. The study also stated the unique method of fabricating FGM structures with a low-cost manufacturing process. FFF process with FGM could have potential applications in medical, structural, and automotive industries by locally varying material properties.

Graduate

*POWER CONSUMPTION INVESTIGATION FOR FUSED FILAMENT FABRICATED SPECIMEN

Primary Author: Hunter Hinshaw, Mechanical Engineering (M.S.)

Co-Author(s)/Collaborators: Shane Terry; Ismail Fidan

Advisor(s): Ismail Fidan

This project describes research comparing various settings of current 3D printers and the effect on part quality and machine efficiency. The goal of this research is to determine the most appropriate parameters with which to 3D print any component. The chosen settings should provide a final product of quality while being efficient within three categories: print completion time, part weight, and Kilowatt-per-hour consumption. The purpose being to establish a set of parameters that will provide the sought-after efficiency on any Fused Filament Fabrication (FFF) 3D printer, in any application, for any production part. These parameters could prove to benefit Additive Manufacturing (AM), saving time, material, and electrical energy cost. This study provides results for the most efficient settings across three parameters: layer height, infill ratio, and shell count. Through testing, given the experimental set-up and parameters, 0.3mm, 3 Shells, 25% Infill was the most efficient array of settings in this application.

Graduate

*MECHANICAL CHARACTERIZATION OF LOW-COST METAL MATERIAL EXTRUSION

Primary Author: Hao Lu, Mechanical Engineering (M.S.)

Co-Author(s)/Collaborators: ZhiCheng Zhang; Andy Pardue, Department of Mechanical Engineering, Tennessee Tech University

Advisor(s): Ismail Fidan

Additive manufacturing (AM), commonly known as 3D printing technology, is an advanced manufacturing technology that has developed rapidly in the past 30 years. Its advantage lies in the rapid prototyping and small-batch production. Today, metal AM is gaining popularity due to its high strength and industrial applicability. However, this technology has a high-cost barrier, and it is not affordable for several end-users due to its initial cost, maintenance/ safety requirements, and trained operator needs. Lately, few companies have developed a new type of filament that could work with any low-cost material extrusion printers. These new filaments contain metal powders mixed with polymers and they could be used for producing metallic parts as the end products. This study presented here provides the unique low-cost Metal Material Extrusion (MME) technology and its mechanical characterization. In this printing technology, specimens are made of Polylactic Acid (PLA) compliant metal powder composite filament using the single head extruder. Printed samples were then allowed to sinter using the open-air furnace. During the sintering process, the bonding agents are melted out leaving the metal powders for fusion. For mechanical characterization, the dog-bone specimens are fabricated using the same procedure for testing the material properties before and after the sintering process and the results are compared with pure metal specimens at the end.

Graduate

*INVESTIGATION OF MECHANICAL, THERMAL AND STRUCTURAL PROPERTIES OF CONTINUOUS FIBER-REINFORCED ADDITIVELY MANUFACTURED THERMOPLASTIC POLYMER COMPOSITES

Primary Author: Mahdi Mohammadizadeh, Mechanical Engineering

Advisor(s): Ismail Fidan

Continuous Fiber Reinforced Additively Manufactured (CFRAM) nylon composites were manufactured and their properties were investigated. Due to the high performance, lightweight, and easy-process, these materials are good candidates to replace metals and conventional composites for a wide range of applications. The wide range of applications of these novel materials justifies the need to study their properties. In this study, fiber-reinforced composite specimens were printed and their mechanical,

thermal and structural properties were investigated. Nylon and onyx were used as the matrix and Carbon fiber, fiberglass, and Kevlar were used as reinforcing agents. The mechanical and thermal analyses including tensile analysis, creep analysis, Dynamic Mechanical Analysis, Thermogravimetric analysis, thermal conductivity, heat capacity, and heat diffusion were investigated. Microstructural analysis was also conducted to investigate the fracture mechanism, internal morphology, interlayer adhesion, and the printing quality of the specimens. The thermo-mechanical properties of printed parts were compared with metals and conventional polymer composites to further investigate the applicability of printed parts. The results clearly show that CFRAM parts have much lighter weight compared with metals and their performance is high enough for engineering applications. In addition, the manufacturing process of these materials is much easier than metals and conventional composites. Finally, the applicability of CFRAM components for fabricating automotive parts was examined. For this aim, ease of design and manufacturing, final price, and production time as three main manufacturing factors were considered. The car parts were printed and their properties were compared with metal parts produced with traditional methods.

Undergraduate

MAKER MEMBER DATABASE DEVELOPMENT

Primary Author: Cameron Clouse, Computer Science

Co-Author(s)/Collaborators: Warren Sims; Hunter Hinshaw, Graduate Assistant-Manager at iMakerSpace; Terry Guo, R&D Engineer at iMakerSpace

Advisor(s): Ismail Fidan

Beginning during the 2019 Fall semester, the Maker Member Database project aims to improve upon the system used to process student applications to the iMakerSpace more efficiently. This goal is composed of time efficiency and cost efficiency. Time efficiency to process certifications and have card access granted should be achieved through an automated system. Such a system would additionally work to solve the goal cost efficiency. As students move from printing numerous documents and turning them in to an automated and paperless system, costs for both students and the iMakerSpace go down.

Undergraduate

POWER CONSUMPTION INVESTIGATION FOR STEREOLITHOGRAPHY SPECIMEN

Primary Author: Blake Dempsey, Manufacturing Engineering Technology

Co-Author(s)/Collaborators: Carter Schunk; Josef Bangean

Advisor(s): Ismail Fidan

The goal of this research project to find the balance between SLA 3D printer settings and power consumed by the machine while keeping the strength and durability of the part being made. The variables being chosen to help us investigate the properties of SLA printing are the type of resin being for the project, which includes, tough, durable, and clear resin, and other settings in the SLA 3D printer software such as layer thickness and hollow parts versus solid parts. This will be accomplished using power gauges on the printers and recording the amount of material being used, the amount of power being consumed, and the amount of time it takes to print the parts. The goal is to find the perfect parameters that that will provide additive manufacturers the information needed to not waste any resources and time on parts being manufactured. By using several different types of resin, this project will also enable future additive manufacturers to make better decisions on the types of resin they use, and help others know exactly what they will be trading off when using one type of resin instead of another.

Undergraduate

IMAKERTRACK: DIGITAL 3D PRINT SUBMISSION SYSTEM

Primary Author: Bradley Harper, Computer Science

Co-Author(s)/Collaborators: Jacob Warren; Robert Shelton; Hunter Hinshaw, Graduate Assistant - Manager at iMakerSpace; Terry Guo, R&D Engineer at iMakerSpace

Advisor(s): Ismail Fidan

The iMakerTrack project is a student-led project that uses a queue system designed to improve efficiency among 3D printed projects for research, showcases, and most importantly class projects. The TTU school of engineering is growing rapidly, and in turn growing the need for students to 3D print models for their classes. Prior to implementing iMakerTrack, students had to find a time in their busy schedule, navigate the maze to find the iMakerSpace, design what they need, just to hope a printer wasn't in the middle of a 30 hour print. The iMakerTrack has reduced the problem significantly by allowing students to submit their designs online, and letting the iMakerSpace handle the rest. With about four staff members monitoring all queue submissions, time management, and print details, printer problems have decreased and print successes have increased. This method also allows the Space to handle multiple submissions by taking two prints that would not use the entire printer bed, and putting them together to finish simultaneously.

Undergraduate

*ADDITIVE MANUFACTURED DINOSAUR SKELETON REPAIR AND UPGRADE

Primary Author: Soraya Olvera-Barrios, Mechanical Engineering

Co-Author(s)/Collaborators: Lizzy Zink; Billy Lian; Evan Kixmiller; Hunter Hinshaw, Graduate Assistant - Manager at iMakerSpace; Terry Guo, R&D Engineer at iMakerSpace

Advisor(s): Ismail Fidan

The dinosaur replica in the iCube Space was deteriorating due to the fragility of the acrylic holding it together. In accordance with this, it was our group's goal to repair it, including reprinting specific parts and finding a new method of adhering the pieces together. Upon inspection, the jaw, neck, and tail became the main focus. The neck joint and jaw reprinted fine but the tail needed some work. Due to instabilities with the reprinting of the tail, only half of it was able to be successfully done. As a result, the redone half had to be glued onto the original half. This was done by taking a dremel to the original and flattening the end out so that the new half could have a better fit. Epoxy was used for most of the readhesion while a 3D pen was also used to help fill in and weld the neck to the head.

Department of Mechanical Engineering

Graduate

*ELECTROMECHANICAL IMPEDANCE BASED STRUCTURAL HEALTH MONITORING DURING A DYNAMIC EVENT

Primary Author: Mohammad Alshaikh Ali, Mechanical Engineering (M.S.)

Co-Author(s)/Collaborators: Eric Nolan

Advisor(s): Steven Anton

This study presents an experiment to determine if damage detection can be achieved in the millisecond timescale with the electromechanical impedance (EMI) method of structural health monitoring (SHM). Typically, SHM is used in static measurements of civil and mechanical structures where change is detected by comparison of a baseline to a present measurement. However, advances in data acquisition permit the possibility of detecting change in a highly dynamic event. In this experiment, a cantilever bar bonded with a piezoelectric transducer is used as the test structure. A 3D printed puck is used as an interface material at the impact location to increase the duration of contact and dampen the dynamic force of impact on the beam. A striker bar is used to impact the cantilever bar. The striker bar is discharged by a pneumatically operated pressure vessel controlled by a solenoid valve. The launching barrel is connected to a solenoid and then a reservoir with a pressure gauge to ensure the velocity of the striker bar is consistent. Prior to monitoring the structure under a dynamic load, a static load is applied to the structure to discover frequencies where change is detected due to the added mass on the structure. These frequencies are excited via a chirp signal. The chirp signal is created such that the sweep time is less than half the measured duration of impact. Results show this setup is capable of continuously exciting and sampling the piezoelectric transducer during impact. Further post-processing of data is underway.

Graduate

*IMPROVING LIFT CHARACTERISTICS OF SUPERCRITICAL AIRFOIL VIA UPPER AIRFOIL SECTION MODIFICATION

Primary Author: Mushrif Choudhury, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Jie Cui, Tennessee Technological University; Vahid Motevalli, Tennessee Technological University

Advisor(s): Jie Cui

The research shown examines changes in the lift performance of a super-critical airfoil by varying the airfoil upper section thickness. This research is motivated by new approaches in dynamic wing re-configuration studies initiated by NASA, where configuration via mechanical wing movement was successfully implemented in military aircraft. FLUENT software is used with ANSYS Workbench in order to develop numerical simulation for compressible transonic flows (Mach number 0.7-0.9). The baseline simulations have been successfully compared with published data and selected experimental results. Preliminary findings point to improvements in airfoil lift characteristics as a result of increasing the upper section thickness of the airfoil.

Graduate

*BIODIESEL YIELD BASED ON THE DIFFERENT OIL COMPOSITION AND MIXTURE RATIO

Primary Author: Saanyol Ityokumbul Igbax, Mechanical Engineering

Co-Author(s)/Collaborators: Ekele Augustine Ogwu, Engineering Materials Research Department, Building and Road Research Institute, Ogun State, Nigeria; Sunday Bako, Mechanical Engineering Department, Nuhu Bamalli Polytechnic, Zaria Kaduna State, Nigeria

Advisor(s): Stephen Idem

Biodiesel is a renewable resource that can be grown quite literally from the ground up. It is a form of diesel that is derived from the transesterification of fatty acids within the oils of plant or animal-based products. These oils have a unique structure that could be varied owing to many factors; temperature, pressure, water, etc. This research looked into the justification for different molar ratio 4:1, 6:1, and 8:1. Owing to the composition and structure of the oils needed to achieve a better yield. Waste Vegetable oil mixed with methanol in proportions of 23.66 grams of lye in the methanol for every subsequent gallon of waste vegetable oil. Results showed that at high fatty Acid Value, the catalyst amount needs to be adjusted with operating temperature in the range of 60- 70 0c to produce yields up to 92-96%. While many forms of raw oil can be used in the production of biodiesel batches, the choice of modification/ improvement on the process must be backed by proper storage measures. The oil chosen for this research was based on the reactive properties and fatty acid chains of waste vegetable oils. The sequences of production has minimal human involvement with support from the Raspberry Pi 3 software which signals different operational commands for producing biodiesel by activating a series of valves, pumps, and temperature devices in order to control liquid flow into & out of different reaction tanks.

Graduate

*MACHINE LEARNING ALGORITHM FOR DETECTION OF LOOSENING AND DEBONDING IN TOTAL KNEE REPLACEMENTS

Primary Author: Brandon Miller, Mechanical Engineering (M.S.)

Co-Author(s)/Collaborators: Nathan Ghattas; Steven Anton, Tennessee Tech University

Advisor(s): Steven Anton

Within the field of structural health monitoring (SHM), there are a few fundamental axioms that make up the baseline for every application of SHM. Among these are the notion that damage classification can only be done by a comparison of two states – one undamaged or baseline state, and one damaged state – and the idea that sensors, on their own, cannot measure damage directly. Thus, post-processing of measurement data is the key to overcoming the latter limitation. The next challenge is, of course, selecting the form of data analysis or algorithm best suited to the system in question. In the case of this research, that system is a simulated total knee replacement analyzed using the electromechanical impedance (EMI) method of SHM. The data being analyzed is comprised of a single healthy baseline case alongside multiple unhealthy states with varying damage modes and severity of damage. All datasets are comprised of impedance data, measured using piezoelectric discs excited along a range of frequencies. In previous research, the datasets were run through a root-mean-square-difference (RMSD) algorithm, and the changes in response between states were determined to be statistically significant. The focus of this work is to use further-post processing in the form of machine learning algorithms to determine whether the data is viable for differentiating between various damage states and their severity. The end goal of this line of inquiry is to further the development of an in vivo sensory system capable of detecting damage prior to total failure.

Graduate

*ELECTROMECHANICAL IMPEDANCE BASED STRUCTURAL HEALTH MONITORING MEASURING SYSTEM IN THE MILLISECOND TIMESCALE

Primary Author: Eric Nolan, Mechanical Engineering (M.S.)

Advisor(s): Steve Anton

Electromechanical impedance (EMI) based structural health monitoring (SHM) is a relatively new field with many applications in static structures. The EMI method uses a piezoelectric transducer to measure the mechanical impedance of a structure via the electrical impedance of the transducer. To expand monitoring to structures operating in dynamic environments requires developing these systems to operate in the millisecond timescale. Methods for taking EMI measurements have been developed using simple voltage divider circuits to dramatically decrease the time of measurement in comparison to traditional systems such as impedance analyzers. In this study, the new EMI measurement system is implemented to continuously monitor a structure to detect changes of state using a LabVIEW based data acquisition system. A baseline measurement of the structure is compared to subsequent measurements, and quantitative differences between the two measurements are calculated using the root mean square error (RMSE). A novel running baseline approach has been implemented to decrease sensitivity to gradual environmental changes by taking the average of the most recent measurements as the baseline. An experiment is conducted to continuously monitor a structure, and the state of the structure is changed by addition of mass to the structure. Initial results indicate the addition in mass is detected by the measurement system, and the original baseline measurement in addition to the new impedance signature of the structure is recorded and displayed. Timing measured by LabVIEW indicates the system monitors a 10 kHz bandwidth in less than 15 ms yielding tremendous promise for dynamic monitoring.

Graduate

*WIND FARM YAW CONTROL: WHY POSITIVE YAW ANGLES CAN ENHANCE THE PRODUCTION, WHILE NEGATIVE ANGLES LEAD TO AN OVERALL LOSS OF POWER?

Primary Author: Reza Nouri, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Ahmad Vaselbehagh, Tennessee Tech University; Cristina Cristina, University of Delaware

Advisor(s): Ahmad Vaselbehagh

The aerodynamic interactions of wind turbines within a wind farm cause major energy losses. While these unavoidable interactions are minimized via layout optimizations prior to the construction of the wind farm, some active treatments can be carried out to further tackle this issue during the operation of the plant. Among all, yaw control has appeared to be the most promising strategy. Studying the impact of intentional yaw misalignment on the wake characteristics and the performance of wind farms has led to the conclusion that proper positive yaw misalignment can lead to an overall increase in the annual energy production of a wind farm, while any negative misalignment always reduces the energy production. Two unverified reasons are proposed for this: (i) clockwise rotation of the turbine blades and (ii) the Coriolis effect. This paper investigates these two potential explanations by conducting six large-eddy simulations of flow through a wind farm of 10 turbines. Results indicate that the Coriolis force and the direction of rotation of the blades both contribute to the significant inconsistency between the impact of positive and negative yaws on the net power production. The Coriolis force, however, was found to be more influential at the studied hub height. For the studied

case, the difference between applying a positive and a negative yaw angle to the front-row turbine was found to be approximately 17%. This difference was reduced to almost 7% when the Coriolis force was relaxed, and to approximately 11% when the turbines were set to rotate counterclockwise.

Undergraduate

*SIMULATION AND OPTIMIZATION OF WIND TURBINE GEOMETRIES

Primary Author: Logan Unser, Mechanical Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Ahmad Vaselbehagh

In this study, the results from academic wind turbine simulation software were compared to viscous unsteady computational fluid dynamic simulations done on the Tennessee Tech High Performance Computing cluster (HPC). The cross section of the vertical axis turbine blade was altered by means of a genetic algorithm in order to produce the highest power coefficient. Python was implemented to automate the setup of the simulation, running the HPC, and post processing data to be inputted back into the algorithm. The simulations were done over a variety of rotational velocities in order to better match a real turbine.

Undergraduate

*3D PRINTING FLEXIBLE CAPACITIVE SENSORS FOR INSOLES AND FLEXIBLE MATERIALS

Primary Author: Jacob Warren, Mechanical Engineering

Co-Author(s)/Collaborators: Nathan Ghattas

Advisor(s): Steven Anton

Accurate gait analysis currently involves a motion capture system coupled with a costly force sensitive platform. There has been previous work in the Dynamic & Smart Systems Lab (DSSL) to use 3D printed flexible conductive filaments to achieve force measurement; this is done by measuring the capacitance between two conductive plates of flexible filament. The 3D printing process used for making these flexible capacitive sensors is Fused Deposition Modeling (FDM). The first approach to make these sensors was to print the flexible filaments separately, and then "stack" them on top of each other in a "pad". The "pad" consisted of a flexible conductive layer on top, a flexible non-conductive layer (the dielectric), and then another flexible conductive layer on bottom. The method for this research utilizes a dual extruder printer; this allows the entire sensor to be printed at once. Printer settings will be developed and optimized to consistently produce a reliable sensor. These single print sensors will be tested and evaluated by themselves and embedded in a non-conductive flexible filament. The test method is to place the sensors, embedded or not, in a load frame to apply and measure the applied force, have their capacitance measured, and then characterize the sensor with the acquired data. This research is ultimately focused on incorporating what has been learned about creating and using these capacitive sensors to place them throughout a fully 3D printed force sensing insole; which will later be combined with a treadmill-based gait tracking system.

College of Interdisciplinary Studies

School of Environmental Studies

Graduate

*EVALUATION OF MICROPLASTIC LOAD IN A WASTE WATER TREATMENT PLANT

Primary Author: Chioma Onwuchekwa, Environmental Sciences Chemistry (Ph.D.)

Co-Author(s)/Collaborators: Tammy Boles, Tennessee Technological University

Advisor(s): Tammy Boles

Production and demand for single-use plastic materials is at an all-time high, resulting in increasing concerns about the proper disposal and end of life treatment of these materials. Plastics can accumulate in the environment and degrade over time into smaller fragments known as microplastics. Microplastics have a diameter of five millimeters (5 mm) or less and can easily be transported across different environmental compartments and trophic levels of the food chain. The aim of this study is to determine the microplastic content of influent, effluent and sludge (watered and de-watered) samples from the WWTP in Cookeville, Tennessee. Grab samples will be collected and passed through three sieves with different mesh sizes. All remaining solids will be digested by wet peroxide oxidation to remove all biological material and separated according to their densities via a saturated sodium chloride solution. Resulting particles will be oven dried, weighed and identified using Fourier Transform Infra-red Spectroscopy. Particle sizes will be measured using a laser diffraction particle size analyzer.

Graduate

SCREENING METHOD DEVELOPMENT FOR THE DETECTION OF SYNTHETIC CATHINONES

Primary Author: Madison Talley, Chemistry (M.S.)

Co-Author(s)/Collaborators: Jeffrey Boles, Tennessee Technological University

Advisor(s): Tammy Boles

Recreational use of synthetic drugs is a problem not just in Tennessee, but nationwide. One of the synthetic drugs that is causing the biggest problem are cathinones (bath salts). These synthetic drugs are constantly being altered in labs all over the country, and the criminal justice system is having a hard time keeping up with the detection of them. This research focuses on developing easier, faster methods for detecting these drugs using instrumentation currently available in forensic chemistry labs. Previously made methods for a GC-MS were analyzed and recreated. Once a working method was found and replicated, a new method was developed and tested using known standards of R(+) Cathinone and eight other commonly abused synthetic cathinones of various concentrations. Unknown samples received from the TBI were then tested. Samples were extracted using Optima Methanol and injected into the GC-MS. A method using the GC-MSn was then developed.

Undergraduate

*DETERMINATION OF MICROPLASTIC CONTENT IN WESTERN TENNESSEE LAKES

Primary Author: Rachel Baker, Chemistry

Co-Author(s)/Collaborators: Chioma Ekechi

Advisor(s): Tammy Boles

Studies have shown that plastics degrade into microplastics with a diameter of 5mm or less. Many studies have been completed on the presence of microplastics in marine environments, with fewer studies on freshwater environments. This study attempts to determine the content of microplastics in two freshwater lakes in Tennessee that have varying degrees of human activity near the lake — Kentucky Lake on the Tennessee River and Maple's Creek Lake isolated in the Natchez Trace State Park. Samples were collected from various locations within the two lakes via bulk sampling. The size of the microplastics were determined with a particle size analyzer, and then the chemical composition of the particles was determined by FT-IR.

Undergraduate

*INVESTIGATION OF RAMAN SPECTROMETRY IN MOLECULES ASSOCIATED WITH HUMAN DECOMPOSITION

Primary Author: Bethann Oberlander, Chemistry

Advisor(s): Tammy Boles

The determination of the time since death occurred, or post-mortem interval (PMI), is an important step in death investigations. Currently, the most common approach for determining PMI has been the application of different types of mass spectrometry. Mass spectrometry requires the sample to be dissolved or derivatized, resulting in sample destruction. Raman spectroscopy is a non-destructive technique that is capable of measuring analytes in samples that are in solid, liquid, or gas phases, making it particularly useful in forensic investigations. For this project, three molecules associated with human decomposition and PMI, hypoxanthine, indole, and 3-methylindole, were measured with both normal Raman and surface-enhanced Raman spectroscopy (SERS) with gold nanoparticles (AuNPs). Normal Raman was performed for the detection of solid analytes in soil. SERS was performed for the detection of dissolved samples in agarose, layered with soil. All analytes were detected in solid-state mixed with soil as well as in the compounds incubated in agarose and layered in soil. SERS will also be carried out in the blood of pigs, an animal more closely related to humans than other animal models. Determination of the concentrations of these analytes in bodily systems of animals will help to establish the means for a limit of detection study (LOD) and narrow down which research animals have the analytes present in their systems for longer-term decomposition studies.

Undergraduate

*A PROPOSAL FOR THE ABATEMENT OF ILLEGAL DUMPING IN WARREN COUNTY WATERWAYS

Primary Author: William Ponder, Environmental and Sustainability Studies

Advisor(s): Steven Sharp

Illegal dumping is the improper disposal of trash in unauthorized locations, such as rivers and forests. Illegal dumping in Tennessee has been an issue for decades. The Tennessee Tech Environmental and Sustainability Studies Capstone Class has focused their attention on Warren County, located in the Upper Cumberland region, to propose strategies for preventing illegal dumping and mitigating the problems associated with it. The negative effects of illegal dumping on the environment, on regional economies, and on local communities are significant. The proposals presented by the research group are meant to address many different facets of the issue. They include the use of GIS as a spatial database of illegal dumpsites and also as a potential predictive model, the study of microplastics and their prevalence in the river ecosystem,

the negative effects of tire dumping, the economic impacts of illegal dumping, how enforcement of environmental laws and regulations have improved other communities similar to this one, and how community awareness along with environmental education can prevent illegal dumping in the future. The abatement of illegal dumping is a necessary component in keeping Warren County waterways safe, healthy, and clean.

Whitson-Hester School of Nursing

Graduate

*IMPLEMENTATION OF AN ADVERSE CHILDHOOD EXPERIENCES QUESTIONNAIRE IN THE PEDIATRIC PRIMARY CARE SETTING

Primary Author: Kassie Barnes, Nursing (D.N.P.)

Advisor(s): Bedelia Russell

Adverse Childhood Experiences (ACEs) are traumatic and stressful experiences that may negatively affect lifelong health and well-being. Due to the barriers of time constraints, lack of consensus on an ACEs screening instrument, and evidence-based treatment options, screening for childhood adversity is not a standard of care in pediatric practice. This project will facilitate and evaluate the implementation of the Yale-Vermont Adversity in Childhood Scale (Y-VACS) in a private pediatric primary care clinic in a medium-sized, suburban city in Middle Tennessee.

The participants in this project include four pediatricians, four nurse practitioners, one physician's assistant, and ten licensed practical nurses. Screening for ACEs will occur during well-child examinations of children ages six to ten years for three months. An evidence-based clinical decision tree for positive ACE screening scores is available to guide participants in choosing treatment options. After the project, participants will assess their experiences of screening for ACEs in the primary care setting with a survey.

Data analysis will include descriptive statistics of completed ACEs screening instruments and positive screening scores with any associated interventions ordered by the healthcare provider. Evaluation of the participants' feedback will consist of: (a) the importance of assessing for ACEs in primary care, (b) experiences with implementing the screening tool, (c) the significance of the decision tree, and (d) evaluating the amount of time spent on addressing ACEs during visits.

This project aims to add to the body of evidence of best practices for evaluating ACEs in the pediatric primary care setting.

Undergraduate

*MESOAMERICAN NEPHROPATHY: A GROWING PROBLEM IN CENTRAL AMERICA

Primary Author: Jacqueline Flowers, Nursing

Advisor(s): Susan Piras

Mesoamerican nephropathy is chronic kidney disease (CKD) that is lacks clear etiology and presents primarily in healthy young men living in Central America. In one report from a town in Nicaragua, the prevalence of CKD was 42% among men and 9.8% among women. From 1992-2002 the CKD-related mortality rate increased from 4 to 10 cases per 100,000 Nicaraguan inhabitants. Patients do not have pre-existing factors such as diabetes or hypertension, setting this type of nephropathy apart from what is typically seen. Research suggests nontraditional

factors contributing to rapid decline in kidney function include; outdoor and agriculture work, lack of shade during work breaks, exposure to pesticides and live in low altitude homes. A patient with mesoamerican nephropathy may present with arthralgias, muscle cramps, dysuria and flank pain. All of these symptoms lead to the prescription of NSAIDs and antibiotics which are both known to cause damage to the glomerulus when used in excess. Physicians and pharmacists in Nicaragua state that they are aware that this is a growing problem in their area and they know the contributing factors. However, what has not been determined is what present practices do they have in place to educate and prevent mesoamerican nephropathy in young males?

Undergraduate

*LOTUS; FLOWER OR NEW BIRTHING PROCESS?

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Although rare, some modern moms are choosing to participate in a lotus birth. Lotus birth, or umbilical nonseverance, is the practice of leaving the umbilical cord uncut after the birth of a baby. Participates in lotus birth leave the placenta and cord attached to the newborn until they dry up and naturally fall off. The current standard medical practice is to cut the cord within the first few seconds after delivery, and it usually takes between 3-10 days after birth for the cord to completely detach from the naval. The women who participate in lotus birth usually treat the placenta with special herbs and salts, and create a pouch to carry the placenta in alongside the baby. Lotus birth owes its modern resurgence in America to a woman named Clair Lotus Day who began to question birthing practices in the early 1970s after learning that certain primates do not sever the umbilical cords of their young. Proponents of lotus birth cite several benefits of this practice, including: improved circulation in the newborn, less risk of infection, overall faster healing of the naval, reduced birth trauma for the neonate, and improved post-partum healing for the mother. However, some medical professionals proclaim that the risks of lotus birth greatly outweigh the benefits. A few scientists have identified a slight correlation between lotus birth and life-threatening conditions for the newborn like sepsis, idiopathic hepatitis, and increased incidence of jaundice. Unfortunately, there is very limited research published in the literature on this subject.

Research Day 2019

National Medal of Technology & Innovation

The National Medal of Technology and Innovation is the nation's highest honor for technological achievement, bestowed by the President of the United States on America's leading innovators.

The medal is awarded annually to individuals, teams, companies or divisions of companies for their outstanding contributions to America's economic, environmental and social well-being. The purpose of the National Medal of Technology and Innovation is to recognize those who have made lasting contributions to America's competitiveness, standard of living, and quality of life through technological innovation, and to recognize those who have made substantial contributions to strengthening the nation's technological workforce. By highlighting the national importance of technological innovation, the medal is also meant to inspire future generations of Americans to prepare for and pursue technical careers to keep America at the forefront of global technology and economic leadership.

Established by the Stevenson-Wydler Technology Innovation Act of 1980, the medal was first awarded in 1985. The first National Medals of Technology were also issued in 1985; among the first recipients were technology giants Steve Jobs and Stephen Wozniak, founders of Apple Computer. The America Competes (Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science) Act of 2007 amended Section 16 of the Stevenson-Wydler Technology Innovation Act of 1980, to change the name to the "National Medal of Technology and Innovation."

The National Medal of Technology and Innovation is the work of medalist and sculptor Mico Kaufman. The obverse side depicts the technologist as something of a modern "wizard," with a concentrated beam bouncing off the palm of his hand, representing the input and the output of technology and of the innovation process. On the reverse is an eagle clutching an olive branch and arrows encircled by the inscription "AWARDED BY THE PRESIDENT OF THE UNITED STATES OF AMERICA."

https://www.uspto.gov/learning-and-resources/ip-programs-and-awards/national-medal-technology-and-innovation-nmti