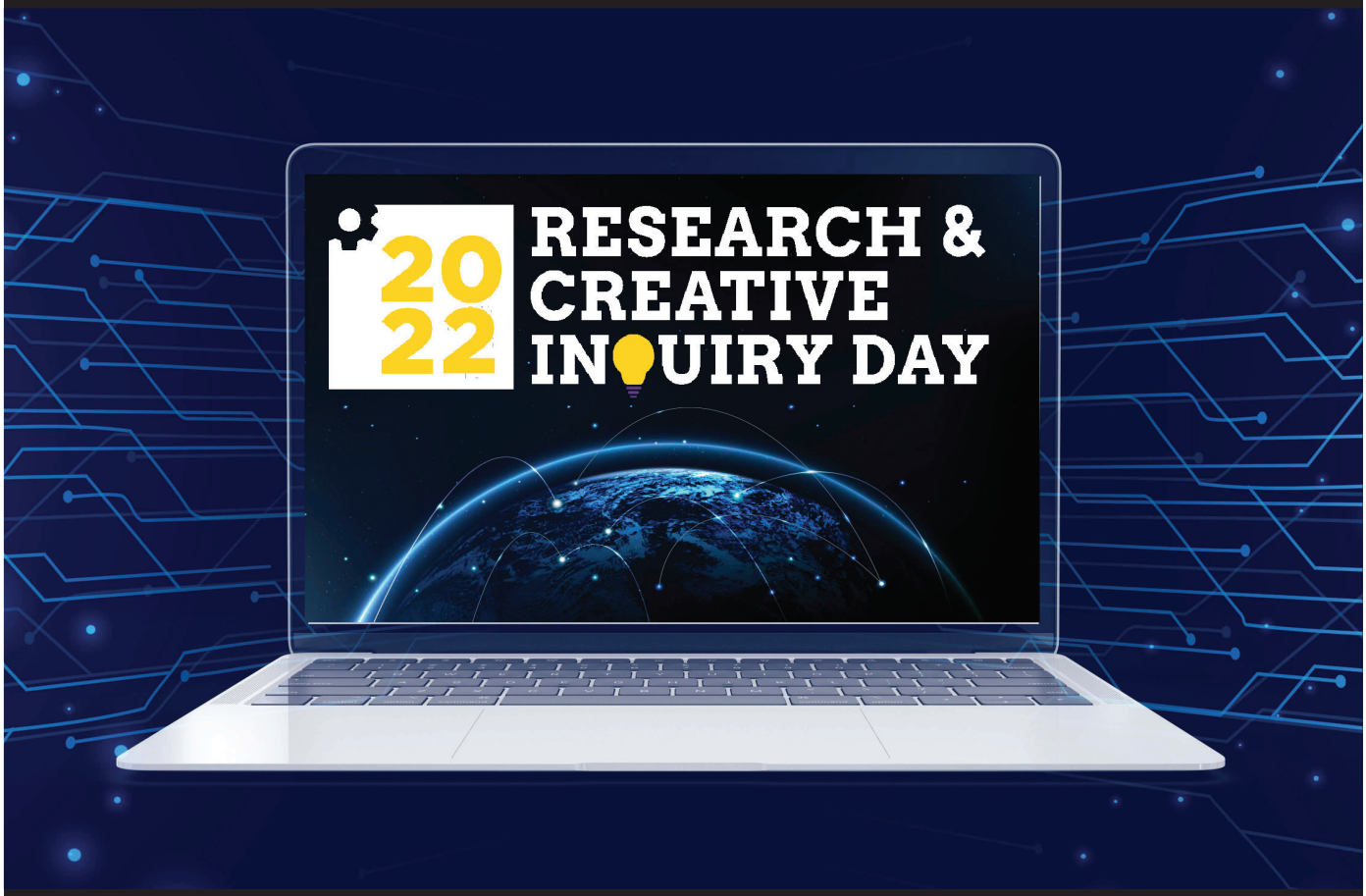

April 20-21, 2022

17TH ANNUAL EVENT

Tennessee TECH

Proceedings

tntech.edu/research/research-day

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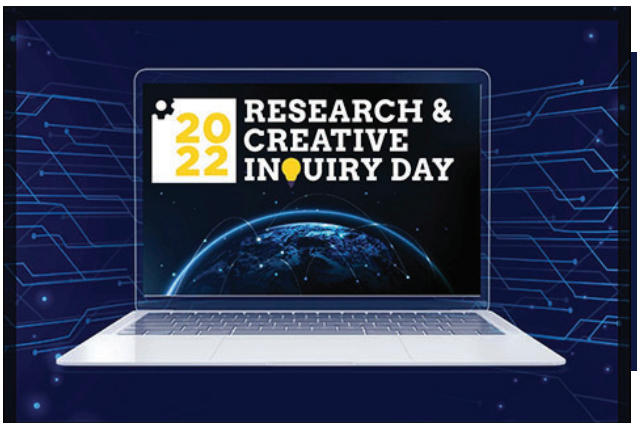

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Tennessee TECH

tntech.edu/research/research-day

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 51,800 students nationally and internationally to Tennessee universities, awards over 17,700 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, Tennessee teachers with advanced degrees are serving as educational leaders in the creation of learning communities that promote academic excellence, critical thinking skills, and lifelong learning as well as engaging in community service activities that reflect an appreciation for the personal and professional rewards of such pursuits; 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 April 4-8, 2022 as

Graduate Education Week

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

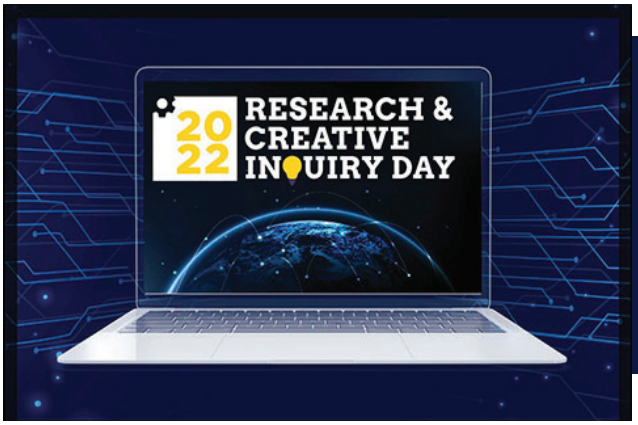
IN WITNESS WHEREOF, I have hereunto set my hand and caused the official seal of the State of Tennessee to be affixed at Nashville on this eleventh day of February, 2022.

Bill Lee

Governor

Tre Hargett

Secretary of State



Foreword

The Office of Research and Economic Development welcomes you to the 17th Annual Research and Creative Inquiry Day. This event provides an opportunity to showcase student research and creative inquiry projects from colleges and 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.

The 2022 Research and Creative Inquiry Day is the first in-person event since 2019. Students returned to the format of printing posters and presenting them for judges at the Hooper Eblen Center. This year's event also features a collaboration with the Center for Career Development, that will be providing resumé-critiquing services and inviting potential employers to be present during the poster-viewing session on Thursday, April 21.

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 April 4-8 as "Graduate Education Week."

This year's event features posters and papers generated from 236 submitted abstracts on topics as varied as the 24 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 and all the other volunteers who donated their time to this year's event. It would not have been possible without the support of the entire campus community.

~ Dr. Jennifer Taylor, Vice President for Research and Economic Development

Special Appreciation & Acknowledgments

Tennessee Tech Offices, Departments and Staff

Athletics; Center for Career Development; Cybersecurity Education, Research and Outreach Center; 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, Holly Mills assistant professor in the Volpe Library, for providing poster-design resources, and the Center for Career Development for providing resumé critiquing and opportunities to network with potential employers.

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

In conjunction with this year's event, you are invited to view a creative media inquiry project that is available on the event web page at tntech.edu/research/research-day/index.php. The video was developed in the Social Problems (SOC 1650) class taught by Ada Haynes, professor of sociology, during the Fall 2021 semester. During this course, students explored a social problem through research with a creative inquiry and sociological lens and as part of the QEP-sponsored redesign of the course, developed creative projects displaying an effective media campaign that promoted awareness and/or offered an innovative solution to the social problem sutdied. One video was submitted for the event. An abstract of the video can be found on Page 58.

Schedule of Events

The 17th Annual Research and Creative Inquiry Day

The 2022 Research and Creative Inquiry event is being held in person at the Hooper Eblen Center. The following is the event timeline:

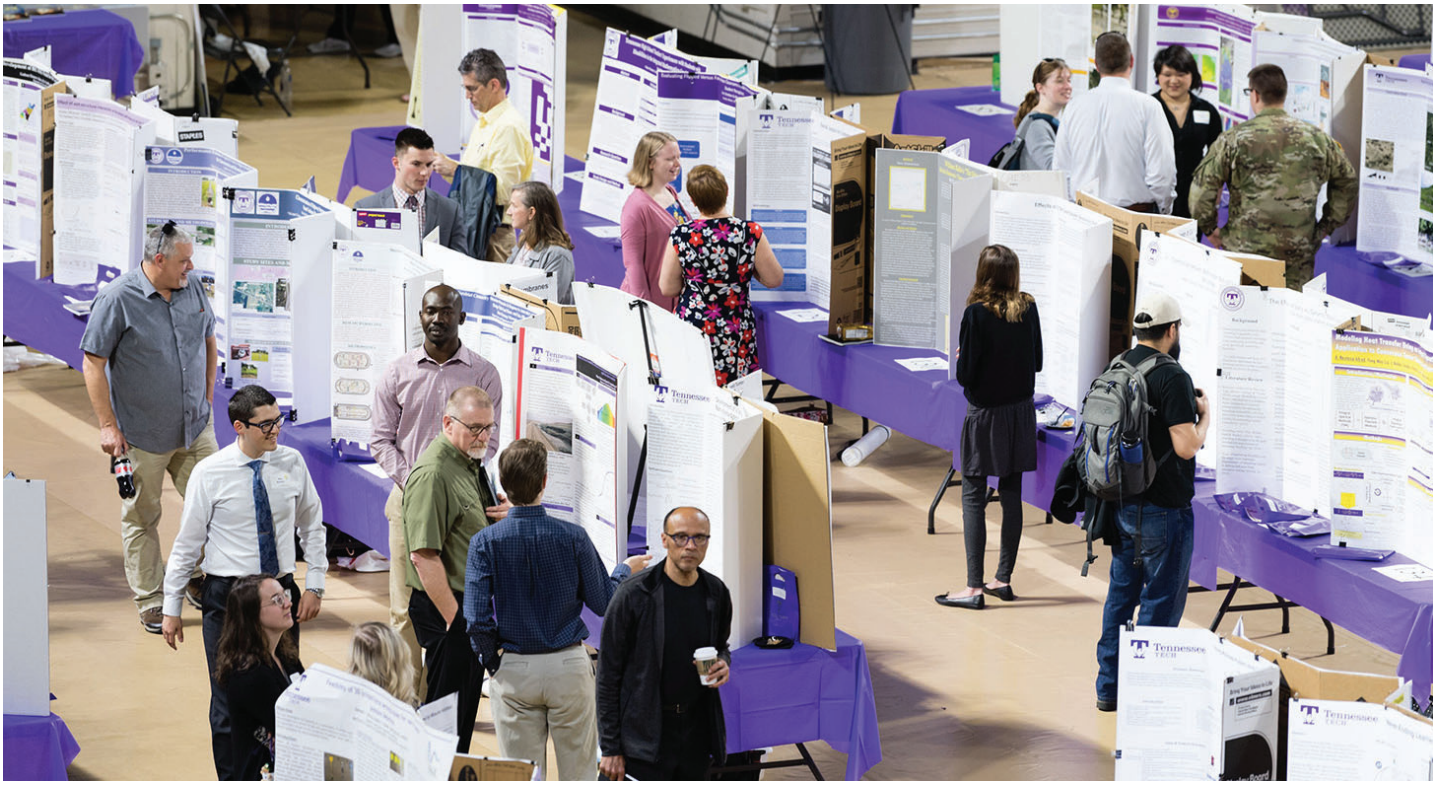
Wednesday, April 20:

- 11 a.m. - 3 p.m.: Student Registration & Poster Setup
- 4 - 6 p.m.: Judging Registration & Judging (Students are invited to be available to discuss posters, and hors d'oeuvres will be served. There will also be give-aways during the judging session; students must be present to win.)

Thursday, April 21:

- 9-11 a.m.: Poster Display for Campus and Community (students are invited to be available to discuss posters, and light snacks will be served.) The Center for Career Development will be offering a resumé-critiquing opportunity, and several employers will be invited for potential networking.
- 11 a.m.-Noon: Awards Ceremony
- Noon - 2 p.m.: Poster Pickup/Cleanup

The paper presentations of the event sponsored by the English Department will be on Wednesday, April 20, in the Volpe Library Instruction Room 112. Kristen Deiter, associate professor of English, is coordinating that portion of the event.



2022 Judges

Bobby Adams – Chemical Engineering
Melinda Anderson – Human Ecology
Holly Portia Anthony – Curriculum and Instruction
Steven Anton – Mechanical Engineering
Megan Atkinson – Library
Arthur Banton – History
Rita Barnes – English
Joe Biernacki – Chemical Engineering
Jeremy Blair – Art, Craft and Design
Dolores Bowman – Nursing
Christopher Brown – Biology
Amber Buckner – Human Ecology
Andrew Callender – Chemistry
Amanda Carroll – Chemistry
Derek Cashman – Chemistry
David Chesson – Mechanical Engineering
George Chitiyo – Curriculum and Instruction
Rufaro Chitiyo – Human Ecology
Scott Christen – Communication
Brad Cohen – Biology
Andreea Cojocaru – Chemistry
Janet Coonce – Chemistry
Kristen Deiter – English
Andrew Donadio – Nursing
Dennis Duncan – Agriculture
William Eberle – Computer Science
Robert Engelhardt – Physics
Ismail Fidan – Manufacturing and Engineering Technology
Perihan Fidan – Curriculum and Instruction
Sheikh Ghafoor – Computer Science
Wilson Gichuhi – Chemistry
Julia Gruber – Foreign Languages
Maanak Gupta – Computer Science
Kimberly Hart – Chemical Engineering
Lynette Harvey – Nursing
Philip Hatch – Sociology and Political Science (Assistant District Attorney)
Nicole Henniger – Counseling and Psychology
Adam Holley – Physics
Maria Cristina Humita – Foreign Languages
Samantha Hutson – Human Ecology
Elena Kazakova – Foreign Languages
Stephanie Kazanas – Counseling and Psychology
Mary Kidd – Physics
Duckbong Kim – Manufacturing and Engineering Technology
Ajit Korgaokar – Exercise Science
Ethan Languri – Mechanical Engineering
Mary Lefave – Nursing
Leora Loftis – Chemical Engineering (August Bioservices, LLC, and Tech Alum)
Parker Lusk – Chemical Engineering (DuBois Chemicals, Inc., Tech Alum)
Satish Mahajan – Center for Energy Systems Research
Bryan Materi – Chemical Engineering (Hitachi Zosen Inova)
Josephine McQuail – English
Colleen Mestayer – Communication
Lauren Michel – Earth Sciences
Holly Mills – Library
Jonathan Moldenhauer – Chemistry
Gene Mullins – Chemistry
Michael Nattrass – Agriculture
Nikki Panter – Biology
Venkata Avinash Paruchuri – Manufacturing and Engineering Technology
Susan Piras – Nursing
Subha Pratihar – Chemistry
Mustafa Rajabali – Physics
Jeff Schaeffer – Water Center
Andy Schmitt – Chemical Engineering (BASF chemicals company)
Bobbi Severt – Exercise Science
Susmit Shannigrahi – Computer Science
Martin Sheehan – Foreign Languages
Cara Sisk – Human Ecology
Chuck Sutherland – Computer Science (Tech Alum)
Doug Talbert – Computer Science
Sandra Terneus – Counseling and Psychology
Denis Ulybyshev – Computer Science
Hannah Upole – Human Ecology
Daniel VandenBerge – Civil and Environmental Engineering
Ahmad Vaselbehagh – Mechanical Engineering
Lenly Weathers – Civil and Environmental Engineering
Matthew Edward Younglove – Music
Matthew Zagumny – Counseling and Psychology
Xuanzhi Zhan – Chemistry

Abstracts

College of Agriculture & Human Ecology

School of Agriculture

Ph.D.

Evaluation of Diatomaceous Earth and Kaolin Clay as Repellents to Periodical Cicada Adults (Brood X) (Hemiptera: Cicadidae: *Magicicada* spp.) in Screen Cages

Primary Author: Martine Bowombe Toko, Environmental Sciences Ph.D.

Co-Author(s)/Collaborators: Jason B. Oliver, jasoliver@benlomand.net; Otis L. Floyd Nursery Research Center, College of Agriculture, Tennessee State University, McMinnville TN 37110; Michael R. Allen; Douglas L. Airhart

Advisor(s): Douglas Airhart

During emergence, periodical cicada adults (*Magicicada* spp.) pose a serious threat to plants in open-field nurseries and orchards in eastern United States. Females of these species lay eggs (oviposit) on a variety of young deciduous trees, which include many plant genera like *Quercus, Cercis, Malus, Acer, Amelanchier*, and others. The potential repellency of Surround® WP (kaolin clay) and diatomaceous earth (DE) was assessed on periodical cicada adult oviposition in screen cage "choice" experiments using two plant varieties (*Malus* spp. and *Cercis* spp.). Both mineral-based insecticides have been known to deter other hemipterans like glassy-winged sharpshooter (GWSS) adults and nymphs. Two choice tests were performed using 181 or 140 periodical cicada adults. Cicadas were released in cages containing three potted trees: two trees were sprayed with either kaolin clay (1.73%) or DE (2.03%), and the third tree was untreated (control). In all four cages, we observed that cicada adults were absent or had a low density on trees sprayed with both kaolin clay (1.73%) and DE (2.03%) compared to those on the control tree at the end of the 4-day experimental period. This study found the potential of two products to reduce cicada egg-laying (ovipositing) damage to further aid nursery managers when developing their pest management programs.

Ph.D.

Industry Leaders' Perceived Critical Thinking Dispositions of Early-Career Employees

Primary Author: Mary Mahan, Environmental Sciences Ph.D.

Co-Author(s)/Collaborators: Dennis Duncan, Tennessee Technological University; Ciana Bowhay, Tennessee Technological University

Advisor(s): Dennis Duncan

Recently, a plethora of research has been conducted to gauge which "soft skills" (communication, critical thinking, teamwork, etc.) are most highly valued in current employees and new hires; as well as if and how institutions of higher education are responsible for aiding college students in developing critical thinking dispositions and skills that prepare them for the global workforce. The purpose of this study was to determine how industry leaders perceive the critical thinking dispositions of their early-career (21-35 years) employees. Participants were

chosen based on their current positions and relationship with the School of Agriculture. A modified version of the University of Florida's Engagement, Cognitive Maturity, and Innovativeness (EMI) instrument was used to capture early-career employees' critical thinking dispositions. Preliminary data suggests that early-career employees strive to be well informed (3.9/5.0), are able to get along with people who do not share the same opinions (3.9/5.0), and are looking for opportunities to solve problems (3.6/5.0). However, they are lacking in their ability to find multiple solutions to problems (3.0/5.0), relate to a wide variety of issues (3.1/5.0), and consider the facts and not let biases affect their decisions (3.1/5.0). Therefore, developing courses and/or pedagogical strategies that promote critical thinking skills will assist students in becoming valuable contributors to the global workforce.

Ph.D.

Knowledge, Perceptions, and Attitudes of AGRN 1110 Students on GM (Genetically Modified) Crops: A Survey

Primary Author: Mary Mahan, Environmental Sciences Ph.D.

Co-Author(s)/Collaborators: Dennis Duncan, Tennessee Technological University; Ciana Bowhay, Tennessee Technological University

Advisor(s): Dennis Duncan

Prior research indicates that college students are motivated to buy organic food based on their interests rather than perceived environmental or worker benefits. The underlying motivations showed discontinuity of knowledge of the benefits and reality of genetically modified (GM) crops. Therefore, we seek to determine AGRN 1110 (Plant Science Laboratory) students' knowledge, perceptions, and attitudes towards GM crops. Plant science students (n = 37) were asked to complete a survey that included the following constructs: knowledge of GM crops, purchasing habits, and personal value. The survey was distributed before and again after a GM crops unit. Preliminary results indicate that 70% believe that a GM organism is produced through genetic modification, 62.5% were unsure if GM products affected their overall health, 57.5% were unsure if GM affected the environment, 45% were unsure if GM should be given as feed to animals, and 70% believed that GM reduced pesticide use. Additionally, 78% did not seek non-GM labels, 38% were unsure if non-GM organic foods were healthier for consumption, 48% did not believe that non-GM organic fruits and vegetables taste better, and 60% had no preference if their food was non-GM or GM. Results from this study can aid educators in understanding the lacking area of knowledge surrounding GM products and understand the personal intrinsic values of collegiate students to address this controversial topic in course content.

Undergraduate Student

Tennessee AFNR Teachers' Perceived Level of Competence in Teaching Food Chemistry

Primary Author: Erin Austin, Agriculture

Advisor(s): Dennis Duncan

The purpose of this study was to determine Tennessee Agriculture, Food & Natural Resources (AFNR) high school teachers' perceived level of competence in teaching the standards associated with the TN Department of Education Food Science program of study. More specifically, one of the research objectives was to determine in-service training needs associated with 26 items linked to food chemistry, and food safety and microbiology. Teachers completed the survey instrument via Qualtrics, and the teachers self-reported that they felt not competent or minimally competent (percent of teachers indicating either level in parentheses) in performing the following: equipping my classroom with food chemistry equipment (52%), explaining the procedures for completing ServSafe training (43%), effectively explain safety issues associated

with food additives (39%), teaching/explaining chemical processes and interactions of constituent components of foods, and teach students to identify chemical properties of food that are affected by production, processing, and storage (35%), describing the basic chemical principles of fermentation (34%), and teaching about the principles and applications of the Hazard Analysis and Critical Control Point (HACCP) system (27%). These results indicate that Tennessee Department of Education staff and university teacher educators need to offer summer in-service training sessions that target the aforementioned items.

Undergraduate Student

Expanding Water Line Infrastructure to Rural Residents of Putnam County, Tennessee

Primary Author: Aaron Lay, Agriculture

Advisor(s): Dennis Duncan

Approximately 730 homes in Putnam County, Tennessee, do not have public, potable water access. Putnam County has acquired federal funds from the American Rescue Plan with the intent to make additions to the existing water line infrastructure. This research set out to gauge resident interest in receiving public water access, prioritize the order in which infrastructure projects were completed, and draw conclusions on resident perception towards receiving this added service.

To confirm the hypothesis that most residents would be in favor and possess a positive perception of this added infrastructure, an online and mail-in survey was administered to each homeowner who doesn't currently have water access. A strategic communication plan was executed to promote and legitimize this survey. The results generated from the completed surveys demonstrate a significant desire for added water infrastructure from a considerable majority of homeowners in the county.

It is concluded that residents without water access realize that families, communities, and economies rely on clean, reliable, and abundant water resources and services. This study calls attention to the select residents' desire not to be included in the project and a sampling of the reasons for this decision. The survey results are geocoded to pinpoint the areas with the most interest. On this basis, the water infrastructure projects should commence with the areas reflecting the highest number of supportive residents.

School of Human Ecology

Undergraduate Student

The Reuse of Raw Materials - What is Most Beneficial in Reducing Construction Waste?

Primary Author: Morgan Agee, Human Ecology

Co-Author(s)/Collaborators: Hannah Bratton

Advisor(s): Hannah Upole

Construction and demolition waste is defined as relatively clean, heterogenous building material debris that come from construction, renovation, and demolition of bridges, roads, and buildings. It is thought that the construction industry uses 50% of all global energy and accounts for 35% of carbon dioxide emissions (Silvia et al., 2020). It is clear that to make an environmental impact, construction waste has to be attended to. The mainstream fix for this is recycling, but how truly effective is recycling? Recycling has processing costs that can virtually diminish its benefits. The idea of reuse eliminates conversion costs and decreases the demand for virgin resources. This research aims to determine the most sustainable way to reduce construction waste - reuse or recycling.

Undergraduate Student

The Correlation Between Eating Disorder Treatment and Dietary Regulation Through Diet Tracking Apps in College Students and Women

Primary Author: Hannah Bailey, Human Ecology

Advisor(s): Rufaro Chitityo

Diet tracking applications are designed partly to aid in eating disorder recovery; however, they often exacerbate the problem. The purpose of this project is to investigate the effectiveness and outcomes of diet tracking app use. Articles used in this project were chosen based on participants' gender and age, investigations of recovering patients/those at risk, and ones conducted by eating disorder treatment facilities, physicians, or dietitians. Key words to search for articles were eating disorders, disordered eating, diet tracking, diet tracking techniques, calorie counting, self-monitoring, and MyFitnessPal. Participants in reviewed studies included college students, young women, recovering eating disorder patients, and individuals considered at risk for developing disordered eating habits. One key finding is 73% of My Fitness Pal users reported that tracking somewhat contributed to their eating disorder and 30% reported significant contribution. Another finding was that those using diet tracking apps for weight control purposes were more likely to report apps as contributing to several eating disorder symptoms than those tracking for health and disease prevention. An inquiry into diet tracking app usage may provide more information surrounding factors impacting eating disorder symptoms in men. Recommendations are that practitioners should stop recommending the usage of diet tracking apps and should use caution when adding recovery-specific apps to a patients' care plan.

Undergraduate Student

Ways in Which Identifying as LGBTQ+ Affects Mental Health

Primary Author: Melody Baker, Human Ecology

Advisor(s): Rufaro Chitiyo

The focus of this project is investigating ways in which identifying as LBGTQ+ affects youths' mental health. The purpose of this project was exploring how identifying as LGBTQ+ affects youths' mental health. The criteria used to select the studies was using these keywords: LGBTQ+, high school, lesbian, gay, and depression. I primarily used the Eagle Search Database to locate articles. Selected articles included relevant information for this project.

The participants in identified studies were youth between 14 and 17 years old who identified as LGBTQ+. The participants were chosen randomly from the academic categories of homeschooled, attending public school, and attending private school. The housing categories chosen from were homeless, living with their biological family, and living with a foster family.

The three most important findings from studies used were 1. youth who identify as LGBTQ+ need support from the people who are around them 2.the stigma that LGBTQ+ youth face leads to an increased suicide rate, and 3.inclusion for LGBTQ+ youth can make a positive impact on mental health. The implication of these results was that LGBTQ+ youth need more inclusion and understanding from the people around them (teachers, peers, parents, and community members). This is important because it creates a foundation on which we can use to lower suicide rates among youth who identify as LGBTQ+ and be allies to things we have yet to understand.

Undergraduate Student

Intimate Partner Violence Impact on Children

Primary Author: Kaitlin Berkley, Interdisciplinary Studies

Advisor(s): Rufaro Chitiyo

The topic of this project is about the impact that IPV has on young children. The problem is the alleged negative outcomes of IPC on children exposed to such violence. The purpose of this project was to explore the impact of IPV in early childhood. The articles included in this project were selected because they were relevant to my topic. These are articles that had key words such as intimate partner violence, children, and impact or effect. I found all the articles through Tennessee Tech's library Eagle Search database. I excluded articles that did not have enough information matching my topic. The participants in the reviewed studies were children who ranged from ages five to 16. The results include three important findings: 1. Negative outcomes are common for children who experience intimate partner violence, and the outcomes impact all aspects of their lives. 2. the impact can display itself through both internalizing and externalizing behaviors. 3. resilience is possible for children exposed or who would have witnessed IPV at a young age, but there must be protective factors in place for them. These results mean that children do not need to experience abuse themselves to be negatively impacted. These children impacted by IPV are witnessing in their homes. Researchers, practitioners, and law makers must raise awareness about these children because not enough is known about the increased risks arising from witnessing IPV.

Undergraduate Student

Should Retailers Choose to Use Sustainable Packaging to Reduce their Carbon Footprint?

Primary Author: Jessica Broh, Human Ecology

Co-Author(s)/Collaborators: Caroline Hood

Advisor(s): Hannah Upole

Plastic packaging includes advantages such as durability, water resistance, insulation, affordability, convenience, and shelf stability (Soares et al., 2021) . However, plastic can end up in landfills, plastic substances can transfer into the food, and toxic gasses are released when creating the plastic packaging (Acquavia et al., 2021). The production of single-use plastic by retailers shows various environmental concerns and also proves to be deleterious to our health, in addition to being responsible for a large amount of plastic pollution. The food industry contributes to this problem greatly, since many of these items come in single-use containers or wrappers (Herrmann et al., 2022). For instance, one plastic bag takes ten thousand years to biodegrade (Johnson, 2019), and the damage caused by pollutants and climate change are

permanent (Bauermeister, 2021). There are much more environmentally friendly materials that can be used such as cornstarch or mushrooms (Johnson, 2019). This research aims to determine if large retailers, such as Aldi, Trader Joe's, and Walmart, should choose to use sustainable packaging to reduce their carbon footprint?

Undergraduate Student

The Short-Term and Long-Term Health Effects of Breastmilk Versus Formula for Infants

Primary Author: Hunter Campbell, Human Ecology

Co-Author(s)/Collaborators: Allison Coutinho

Advisor(s): Allison Coutinho

The purpose of this review of literature was to explore the short-term and long-term health effects of breastmilk versus formula. Proper nutrition in the early months and years of a child's life is critical to his or her development. Both breast milk and formula provide essential calories, vitamins, minerals, and other nutrients to infants for survival, and there are known benefits to both. Many articles are focused on the benefits of breastfeeding as opposed to formula, but the choice between the milk itself, from the breast, versus formula is less discussed. The Journal of the Academy of Nutrition and Dietetics and the Tennessee Technological University Library Database Eagle Search were searched to find the research literature that included either breastmilk or formula use in regard to health effects. The goal in searching was to find the most specific, credible, and informative articles on the short-term and long-term effects of the two infant nutrition methods that could be used to make a hypothesis. Articles that met the criteria were analyzed and placed in categories supporting either formula or breastmilk as the better choice for infant nutrition. Results showed that the majority of articles support breastmilk. Although there are limitations to the research conducted, it can be concluded that breast milk is the most beneficial method of infant nutrition focusing on short- and long-term health.

Undergraduate Student

Ways Teachers Accommodate Children with Sensory Processing Disorder Needs in the Classroom

Primary Author: Maggie Clem, Human Ecology

Advisor(s): Rufaro Chitiyo

The topic of this project is to find in what ways teachers accommodate children with Sensory Processing Disorder (SPD). The problem identified is that children with SPD need accommodations within the classroom in order to improve their behaviors and everyone (teacher and other children) else's daily lives. Therefore, the purpose of this project is to investigate the ways in which teachers do and can accommodate the classroom for children with SPD. The key words used to identify the literature reviewed include the following: sensory processing disorder, children with sensory processing disorder, sensory processing disorder needs, accommodations, teachers. The participants in the literature reviewed included teachers, children with sensory processing disorder, and professional counselors. These studies were chosen for this literature review project due to their definition of sensory processing disorder in children, how the disorder affects children in the classroom setting, and recommendations for ways teachers accommodate children in the classroom setting. These findings tell us that the information is widely available to teachers and parents of children with sensory processing disorder. It also reinforces the importance of the problem: that children with sensory processing disorder do face issues in the classroom setting, so teachers should accommodate for these needs in order to improve the child's and others' daily lives.

Undergraduate Student

Factors of the Alleged Increase in Domestic Violence during the COVID-19 Pandemic

Primary Author: Hannah Frisbey, Human Ecology

Advisor(s): Rufaro Chitiyo

Since April of 2020, we have endured a time of confinement within our families due to the restrictions resulting from the COVID-19 pandemic. Because of this, domestic violence cases have allegedly increased which has placed many individuals at risk. The purpose of this project is to explore factors associated with increased domestic violence during the COVID-19 pandemic. Keywords such as factors, COVID-19, and domestic violence were used to identify existing studies for this project. If the articles studied factors of domestic violence before the pandemic or included previous relationship issues, they were excluded from my project. Participants ranged from college students in romantic relationships to individuals in marital relationships and were selected using random assignment, snowball, and network sampling. After studying these participants, results show an increase in domestic violence due to having weak social support systems, no access to social services, and an increase in negative emotions. As the increase in domestic violence during the pandemic has placed many individuals at risk, successfully identifying the reasons behind this can help professionals competently work with susceptible individuals. Social services should remain open as much as possible to help keep victims' social supports strong and negative emotions at bay. In the future, we should focus on ways of identifying valid solutions to help decrease abusive behaviors for both men and women.

Undergraduate Student

Leather and Faux Leather Products: Impact on Society

Primary Author: Flavia Gjishti, Fine Arts

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

Co-Author(s)/Collaborators: Ansley Phifer

Advisor(s): Hannah Upole

Many of us use leather goods for clothing, accessories, or upholstery. But how aware are we as consumers of the impact leather has on our society? From an environmental viewpoint, leather has the greatest influence on eutrophication, an ecological problem which takes away the availability of light and certain nutrients to an ecosystem. Also, turning hides into leather requires massive amounts of energy and dangerous chemicals, including mineral salts, formaldehyde, coal-tar derivatives, and various oils, dyes, and finishes, some of them cyanide-based (PETA, 2021). From a humanistic viewpoint, young and adult workers of the tanneries in Bangladesh expose themselves to chemicals which are harmful to their skin and respiratory organs (Vicenews, 2015). To replace leather, vegan leather is being introduced in the market. Alternatives to leather such as kombucha or plant-based leather, such as the pineapple-based Pinnatex, are being considered. Faux leather uses fewer animal products compared to genuine leather. On the other hand, most mainstream vegan leathers are made from polyurethane leather, which is not biodegradable-a concern for the sustainability of vegan leather (Nera Tanning, 2018). As this is a complex issue that many consumers are unaware of, this research aims to inform the consumer about the use of leather and its alternative products, the impact on the waste these options have on the environment, and ethical issues based on the three pillars of sustainability.

Undergraduate Student

Can Shoes Become Shingles?

Primary Author: Cierra Hall, Human Ecology

Co-Author(s)/Collaborators: Hannah Bernhardt

Advisor(s): Hannah Upole

What do you do with your shoes once you decide you no longer want them? An estimated 20 billion shoes are produced every year and 300 million of them end up in a landfill. (The Shoe Industry, n.d.) The environmental impact from shoe waste is astronomically harmful, such as the pollution from runoff and chemicals released in decomposition. Shingles are one of the most common building materials, but they do not have a long life expectancy, so these materials will end their lifespan in a landfill. Shoe soles and tires are both made of rubber compounds, making them similar in the formation and degradation processes. There has been promising research regarding tire conversion into housing materials, suggesting a potential link could exist between shoe soles and shingles. This research aims to determine the feasibility of turning shoe waste into shingles.

Undergraduate Student

Saving Our Earth: Slowing Down the Fast Fashion Industry

Primary Author: Marissa Heiskell, Human Ecology

Co-Author(s)/Collaborators: Abigail Webb

Advisor(s): Hannah Upole

Today's fashion consumers thrive in the industry with unique outfit creations and styles while our earth suffers the consequences of the horrific textiles industry and the ever-present battle of sustainability. The fashion industry contributes greatly to global CO2 emissions, water consumption, water pollution, microplastic pollution, and waste production (Niinimaki et al., 2020). The industry has already reached double the textile production since 2000 and will continue along this path unless we continue to go forth and recognize the ethical misconduct of the textile industry. The fast fashion phenomenon pushes consumers to buy more and provides apparel with shorter lifespans, which further adds to the world's environmental damage and has made it difficult for efforts to increase sustainability to create an impact. Businesses can drastically change their ways by putting in more effort to use certain materials instead of wasting water and using so many chemicals in their current production. We need to slow down. We need to stop producing and consuming clothes without a second thought and at such fast and unsustainable rates. This research project aims to educate people on how to bring back the values of sustainability in a world dominated by fast fashion.

Undergraduate Student

Today's Fast Fashion

Primary Author: Lauren Jackson, Human Ecology

Co-Author(s)/Collaborators: Jimmia Ward

Advisor(s): Hannah Upole

Is there a need for fast fashion? Fast fashion is around because retailers have to cater to growing fashion trends. Fast fashion is all about the quick response, and it is becoming the most popular shopping demand. This allows retailers to fill their stores with clothing for their target market to benefit the consumers. Not only is fast fashion popular now, but it is predicted to continue growing more in the future. Fast fashion does not stray off from the traditional standards and concepts of clothing. This research aims to show that fast fashion is not as durable as people think, but it has potential to serve a purpose.

Undergraduate Student

Recycling Strategies for Hyundai in Middle Tennessee

Primary Author: Preston Lamson, Human Ecology

Co-Author(s)/Collaborators: Emily Lasser

Advisor(s): Hannah Upole

Recycling decreases the amount of waste that would otherwise end up sitting in landfills and eventually be incinerated. Another benefit of recycling is the conservation of natural resources. Using recycled materials for the structure of cars is a relatively new method that is becoming more popular as people are growing more conscious of the environment's health. Hyundai Motor Company has stated, â€œour commitment to environment and mobility affects everything we do, from the cars we design to the buildings we design them in and everything in between. The all-new 2022 Hyundai Ioniq 5 is the living vision of the company's goal to be carbon neutral by 2045, which includes the production of cars and transportation methods for the company. The main obstacle standing in the way is more than likely the electrical infrastructure. â€œFrom January 2022 to July 2024, Electrify America plans new metro changing investments in the communities of Dallas, Detroit, Nashville, Orlando, Providence, Bakersfield, Stockton, and many other metropolitan areas across the nation. The Middle Tennessee area would have to have more spaces dedicated to charging stations and have eco-fuel available for purchase at many locations. This research aims to show marketing efforts from Hyundai in Middle Tennessee for electric platforms.

Undergraduate Student

Impact of Divorce on Children

Primary Author: Hanna Lewis, Human Ecology

Advisor(s): Rufaro Chitiyo

In this review I will be looking at the impact of divorce on children. The problem is that divorce has been shown to be an Adverse Childhood Experience (ACE). The purpose of this project is to explore the impact of divorce on school-age children's academic achievement. The articles I found were chosen based on if they were a good fit for the topic of exploration. I excluded articles that did not correlate to the topic. The key words I used to search for articles include divorce, academic achievement, socioeconomic status, and school-age. The databases in which I found the studies were Google Scholar and Tennessee Technological University Library. The participants in the reviewed studies included school-aged children, divorced parents, lower economic status parents, higher economic status parents, and parents'education level. In the studies found participants were randomly selected based on age and marital status. Children from single parent homes, especially ones with mothers, have lower academic achievement because of being raised in a stressful environment. Parental support also plays a role because lower parental support was shown to lead to decrease in children's motivation. These results connect to the purpose of this research because it narrowed down different factors contributing to academic achievement with children who have divorced parents. In the future researchers could investigate changes in children's developmental progress right after divorce occurs.

Undergraduate Student

The Correlation Between Foster Care Placement and Children's Behaviors

Primary Author: Molly Newman, Human Ecology

Advisor(s): Rufaro Chitiyo

The topic of investigation for this project is the correlation between foster care placement and children's behavior. There has been evidence that children's behavior is affected due to being in a foster care placement. The purpose of this project is to see how placement in foster care had an alleged effect on children's behaviors. The databases that were used in this research was from Eagle Search. The key words that were used to find existing research are foster care placement, children's behaviors, and behavior management. The participants in these studies ranged from 0-18 years old who were in a permanent foster care placement. The authors gathered data from the National

Survey of Child and Adolescent Well-Being (NSCAW). The main findings were that 1. Children who were in foster care placement externalized their behaviors more than children in non-foster care placements. 2. Children in foster care have an increased risk of mental health issues 3. Children engage in riskier behaviors more than non-foster care children. 3. One of the most impactful experiences a child can go through is being in a foster care placement which can lead to unwanted behaviors. Sometimes, children have a hard time regulating emotions that could lead to unwanted behaviors. Researchers can gather this data to find effective interventions to help children in foster care placement.

Undergraduate Student

The Effects of Nutrition Education on Female Collegiate Athlete's Nutrition Status

Primary Author: Sarah Perez, Human Ecology

Advisor(s): Allison Coutinho

The purpose of this literature review was to examine the nutrition status and health concerns in female collegiate athletes, and explore whether nutrition education benefits or impacts these athlete's nutrition status. The current state of nutrition in female collegiate athletes is widely unknown because much of the research conducted with these athletes was completed several years ago, thus more research is needed in order to understand the current nutrition status of female collegiate athletes as well as the implications of nutrition education on their nutrition status. The Tennessee Technological Volpe Library Databases, along with the Journal of the Academy of Nutrition and Dietetics, as well as the Journal of Sports Nutrition and Therapy were used to locate research literature pertaining to the nutrition status of collegiate female athletes, and nutrition intervention in athletes. Few articles were found, but those found were categorized by the athletes' perceived and actual nutrition intake with lack of prior nutrition education, and the effects of nutrition education on intakes in athletes with prior nutrition intervention. The overall results concluded that the effects of nutrition education positively affected these athletes' nutrition status. Although there is a great lack of research in this area, from this literature review it can be concluded that there is a positive correlation of nutrition education on the nutrition status of collegiate female athletes.

Undergraduate Student

Fathers' Mental Health Outcomes Resulting from a Partner Experiencing a Miscarriage

Primary Author: Caitlyn Phillips, Human Ecology

Advisor(s): Rufaro Chitiyo

The topic of this project is fathers' mental health outcomes resulting from a partner experiencing a miscarriage. The problem is that there is alleged deterioration of fathers' mental health after a miscarriage. The purpose of this project was to explore how fathers' mental health is affected by experiencing a miscarriage. The criteria used to select articles for inclusion in this project was searching for keywords in databases through Tennessee Tech's EagleSearch and Google Scholar. The keywords used were fathers, miscarriage, and mental health. Articles that did't include keywords selected or were outdated were excluded. The participants in the reviewed articles were fathers from around the world whose partners had suffered a miscarriage. Major findings from existing research were 1. the fathers were able to accept the miscarriage but struggled with feeling helpless, 2. there were depressive symptoms in the fathers' post miscarriage, and 3. there were many negative feelings that occurred including feelings of isolation and not wanting to be a burden. These findings support the notion that the mental health of fathers after a miscarriage is just as important and should be addressed when the event occurs. It is important for there to be more research done surrounding this topic as there

is still not a lot of information out there. As professionals there needs to be a sense of urgency to help these fathers that have experienced a miscarriage.

Undergraduate Student

Clothing Durability: Shein vs. Sustainability

Primary Author: Kaylan Randolph, Human Ecology

Co-Author(s)/Collaborators: Peyton Overton

Advisor(s): Hannah Upole

How often do you have to repurchase online clothing due to lack of durability? With the fashion industry always changing and weighing in on what the "next big thing" is in design and aesthetics, the question of quality in production has raised major concerns for consumers. Retrospectively, consumers want their money to go toward items that are durable and will last them a long time. However, the rise in media and consumerism has exposed the public to faster-moving trend cycles, which means a faster moving production cycle. Therefore, the production cycle has to sacrifice things such as sustainability and ethical issues. One way to see the change in durability would be to compare fabric compositions from today's trends to the trends of the 1970s. This research aims to determine if clothing today is as durable as clothing produced fifty years ago.

Undergraduate Student

Covid-19 and the Effects of Mental and Physical Health of School-Aged Children

Primary Author: Hannah Smith, Human Ecology

Advisor(s): Rufaro Chityo

The topic of this project is Covid-19's effect on school-aged children's mental and physical health. The problem is children were put at risk causing their mental and physical health to suffer. The purpose of this project is to explore how Covid-19 allegedly led to the decline in school-aged children's mental and physical health. The key words Covid-19, school-aged children, mental and physical health were used on Tennessee Tech's Eagle Search. I chose the articles based on the abstract information relating to my topic. The excluded articles did not meet the criteria based on key words such as non-school aged children. The participants in the reviewed studies were school-aged children six to 12 years of age from different ethnicity with random and convenience being the sampling. One of the most important findings was to prioritize mental health interventions for school-aged children by setting routines. This helps their physical activity because otherwise they are more likely to sleep and take advantage of screen time. Also, children who worry about being affected by Covid-19 are likely at risk for having depression symptoms. The implications of these findings show the need for routine to protect school-aged children's mental and physical health. School systems and parents at home need interventions for school-aged children's mental health needs to ensure that these children's physical and mental health don't suffer.

Undergraduate Student

Rethink How you Reduce, Reuse, and Recycle

Primary Author: Delaney Stephens, Human Ecology

Co-Author(s)/Collaborators: Courtney Swafford

Advisor(s): Hannah Upole

The term recycling might bring to mind the phrase, "reduce, reuse, recycle" or the big blue bins that never seem to be clearly marked as to what items belong in them. As taught in grade school it is important to recycle materials like paper, plastic, and glass. However, recycling has a much greater capacity than most people realize. Recycling unsuspecting items such as computers, batteries, and you guessed it, clothing, can drastically reduce the

amount of garbage that goes into landfills. By teaching others about the importance of recycling clothes, if all clothes are recyclable, and how to recycle clothes, the act of recycling could make a much bigger impact. In fact, recycling clothing can be just as simple as dropping your water bottle into the infamous blue bin. It is essential for us to do what we can and educate one another about the impact recycling can have if done together. Recycling not only ensures less trash build-up in landfills, but it can also increase the amount of sustainable products manufactured. In turn, those sustainably made products could be recycled time and time again. If there is a gap of knowledge that is keeping people from recycling things like clothes, will there ever be enough people taking initiative to actually make a difference? This research aims to determine if enough people are recycling their clothes and just how many people must recycle to make a difference in the world.

Undergraduate Student

The Correlation Between Adverse Childhood Experiences and Children's Behavior

Primary Author: Dakota Thompson, Human Ecology

Advisor(s): Rufaro Chitiyo

This project focused on the correlation between adverse childhood experiences (ACEs) in elementary age children and their exhibited behaviors. The problem is there are negative behaviors evident in elementary aged children who have experienced ACEs. The purpose of this project is to explore the correlation between ACEs and children's behavior. The databases searched for articles for use in this project were Google Scholar and Tennessee Tech University's Volpe library. The keywords used were child maltreatment, childhood trauma, and behavior. The inclusion of articles was based on the relevance to the topic. The participants in the reviewed studies were school aged children and adults. The three most important findings were 1. struggles with attention, learning, emotion, and memory affect emotional regulation in children, 2. different forms of childhood maltreatment have behavioral effects, and 3. children who have experienced ACEs suffer long-term effects. These results connect to the purpose of this study because they show there is a correlation between ACEs and children's psychiatric health and behaviors. The results outlined above support the notion that children who have experienced ACEs are affected both academically and mentally. Having such experiences also affect children's attention, emotions, memory, and behaviors. A child's mental state influences the way a child behaves within their environments and these effects may be long term.

Undergraduate Student

Parent Satisfaction Rates in Relation to Child Life Program Size

Primary Author: Emma Waltenbaugh, Human Ecology

Advisor(s): Rufaro Chitiyo

The topic of this project is how parent satisfaction rates relate to Child Life Program Sizes. The problem is that child life programs are often understaffed. The purpose of this project is to explore the relationship between child life program size and parents' satisfaction with hospitals. In choosing articles for this literature review, an article was a good fit if it contained key words such as parent satisfaction, child life programs, or Certified Child Life Specialists (CCLS). The research needed to be related to parent satisfaction in hospitals or child life programs. I found my articles in Google Scholar or the Tech library database. The participants in these studies were either parents of children in hospitals or child life specialists. The authors sampled participants by inviting parents of children in hospitals to participate. Another study conducted research as they were implementing a child life program. The findings were 1. parents are typically satisfied with child life interventions, 2. parents experienced less concern

regarding their child's emotional state, and 3. families expressed they valued the breaks given to them by the CCLSs. Thus, the more CCLSs are available, the more parents will experience these things. This in turn will raise parent satisfaction rates. The implications of this are that hospitals will benefit from hiring more CCLSs. In the future, researchers should explore the relationships between child life program size and CCLS satisfaction.

Undergraduate Student

Effects of Probiotic Implementation on Women with Anorexia Nervosa

Primary Author: Cidney Woodard, Human Ecology

Advisor(s): Allison Coutinho

The purpose of this literature review was to explore the effects of probiotics on the gut microbiota of women diagnosed with anorexia nervosa. Anorexia nervosa is a psychiatric disorder with a high mortality rate and is diagnosed if a patient experiences strong self-restraint to consume foods. The gut microbiota plays a direct role in the patient's ability to gain weight after being altered due to starvation. The gut microbiome consists of varying bacterial strains depending on the type of birth the patient experienced (cesarian or vaginal), types of foods consumed, and stress levels. The gut microbiome can be improved by altering the diet and implementing both pre- and probiotics. Several studies have highlighted that implementing probiotics, specifically liquid probiotics, can aid in the proliferation of beneficial bacteria in the gut lining leading to weight restoration. Continued research is needed to better understand anorexia nervosa as a psychiatric disorder, probiotic implementation as a nutrition therapy option, and probiotic effects for anorexia nervosa.

College of Arts & Sciences

Department of Biology

M.S.

Examining Snapping Shrimp Morphology Using Geometric Morphometrics in a Phylogenetic Framework

Primary Author: Anchita Casaubon, Biology M.S.

Advisor(s): Carla Hurt

The snapping shrimp genus Alpheus (ca. 331 spp.) comprises an ecologically diverse, species-rich genus that displays a tremendous amount of variation in key morphological characters. However, despite this dramatic variation in morphology, Alpheus is well-known for harboring numerous cryptic species complexes, many of which have been revealed only by molecular tools or subtle phenotypic differences. This necessitates a closer examination of snapping shrimp morphology to identify characteristics of additional diagnostic importance. Our study uses geometric morphometrics in a phylogenetic framework to quantify the shapes of characters that have historically been used in species diagnoses and identification. We digitized the major chelae and rostrums across three species from the Alpheus gracilipes species complex to test the reliability of geometric morphometrics in species diagnosis and will compare our results against those of Nomura & Anker's 2005 study. Additionally, we designed primers specific to Alpheus shrimp to amplify the 12S gene region, and analyzed partial sequences from the COI, 16S, and 12S mitochondrial genes for all shrimps (n = 7) in the Alpheus gracilipes species complex. Results from this study will be used to generate an updated list of diagnostically informative characters and provide a baseline for other species complexes.

M.S.

Development and Application of an eDNA Assay to Delineate the Distribution of the Imperiled Striated Darter (Etheostoma striatulum, Page and Braasch 1977) in the Duck River, Tennessee

Primary Author: Adam Walker, Biology M.S.

Co-Author(s)/Collaborators: Carla Hurt; Kit Wheeler

Advisor(s): Carla Hurt

Effective conservation of rare or imperiled species relies on efficient monitoring and accurate information regarding distribution, critical habitat locations, and occupancy. However, most imperiled species are inherently cryptic and difficult to capture due to patchy distributions and low population densities. To avoid these obstacles, environmental DNA (eDNA) detection techniques have been developed to provide a more sensitive and economical solution for species monitoring. Striated Darters are small, uncommon darters endemic to the middle-to-upper regions of the Duck River, Tennessee. Since their description in 1977, they have become increasingly rare throughout their range; as of 2011, their distribution had declined to nine of the 16 historically occupied tributaries. Due to this documented decline, Striated Darters are currently in review for federal listing under the Endangered Species Act and are currently listed as state threatened in Tennessee. Because of their reclusive and cryptic behavior, conventional techniques tend to be less effective for detection, requiring more sensitive methods. Our study aimed to develop an eDNA surveillance assay and protocol to detect presence of the Striated Darter at 30 historical

sampling sites and to delineate their current distribution. Data were analyzed using a hierarchical occupancy model approach to estimate occurrence and detection probability at the scales of sites, sample replicates, and qPCR reaction replicates.

Undergraduate Student

Pollen Tubes and Reproductive Success of Physaria globosa

Primary Author: Jojo Brown, Environmental and Sustainability Studies

Co-Author(s)/Collaborators: Emily Powell; Shawn Zeringue-Krosnick, Tennessee Technological University

Advisor(s): Shawn Zeringue-Krosnick

Physaria globosa (Desv.) O'Kane & Al-Shehbaz (Short's bladderpod) is a Federally endangered species limited to 31 populations in Tennessee, Kentucky, and Indiana. This species may have anywhere from one to 40 compound racemes that undergo anthesis in April through June. This study aims to examine how timing of anthesis within the compound raceme may affect reproductive success. Flowers produced earlier in the season or at specific positions within the inflorescence may experience different probabilities of successful pollination. Likewise, the plant's total resource availability could limit ovule/seed development. To explore how flower position might relate to reproductive success, samples were collected from five populations: two in Tennessee, two in Kentucky, and one in Indiana. 10 plants with ample flowers and fruits were selected at random from each population. For each plant, one whole flowering stem was preserved in FAA and later examined with aniline blue under fluorescence. Pistils were numbered based on their location on the main raceme and their position along each branch. The presence of pollen tubes in the ovary was scored as an indirect measure of successful pollination and fertilization. Preliminary results show that pistils present along the primary inflorescence axis may have greater reproductive success relative to other positions within the inflorescence. These data will be considered with regard to their possible conservation implications for P. globosa.

Undergraduate Student

Environmental DNA (eDNA) surveillance of the threatened Slender Chub (Erimystax cahni) in the Clinch and Powell Rivers in Tennessee

Primary Author: Jessee Griffith[1], Environmental and Sustainability Studies

Co-Author(s)/Collaborators: Robert T. R. Paine[2]

Advisor(s): Robert T. R. Paine

Slender Chub (Erimystax cahni) is one of the many freshwater fishes in Tennessee that has been impacted by anthropomorphic factors, such as coal mining and agricultural runoff. Like many other threatened fishes in the Clinch and Powell rivers, Slender Chub has experienced a severe population decline. In fact, not a single individual has not been caught since 2008. However, while individuals have been reported during traditional surveys, these individuals are thought to be aberrant sister taxa (Streamline Chub, Erimystax dissimilis). Given the rarity, potential extirpation, and difficulty in visual identification during traditional surveys, molecular surveillance may offer a new approach to help with monitoring Slender Chub. Environmental DNA (eDNA) surveillance is a molecular approach aimed at collecting and analyzing the discarded biological components of a target animal as a proxy for the presence of the animal. The objective of this proposed study is to survey the Clinch and Powell rivers using eDNA surveillance. Specifically, we will use quantitative PCR (qPCR) for species-specific identification and eDNA-metabarcoding to characterize the entire fish community. Used in tandem, qPCR and metabarcoding also provide additional inference into biological variables associated with the presence of the target species.

Surveillance is planned for summer 2022, during spawning season. Currently, a metabarcoding reference sequence is being generated for Slender Chub, and two qPCR-eDNA assays are being optimized. Results from our project will help resource managers develop updated conservation efforts and make more informed management decisions.

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Undergraduate Student

Fractionation of Serum to Identify the Serum Protein that Effects Reversion Frequency of Small Colony Variant Staphylococcus aureus

Primary Author: Luther Hamby, Biology

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Bailey Ebersole; Maya Johnson

Advisor(s): David Beck

To identify a protein in serum that causes a change in small colony variants (SCV) Staphylococcus aureus rate of reversion to normal colony variant (NCV). SCV S. aureus is a slow growing form of the bacteria. It does not utilize the electron transport chain and is problematic because they are resistant to antimicrobials. These forms are persistent in a host. They are more commonly seen in patients under long-term antibiotic treatment. The reversion rates of SCV can be altered by the presence of certain protein(s) within serums. After reversion, the NCV is easier to detect in a laboratory setting and, therefore, can be identified accordingly. We utilized a Phenyl column, which fractionates samples based on hydrophobicity. The serum was bound to the column, and then fractions were eluted with lower salt concentration and increasing ethylene glycol. We then tested these fractions on different strains of S. aureus - B04Z007 and A42Z008A. Growth and reversion rates were analyzed for increased reversion, and fractions with positive results were separated by SDS-Page. We determined that our protein was quite hydrophobic, elutes with ethylene-glycol. We performed this column run 3 times, and had consistently positive results in the ethylene-glycol fractions. To further separate the protein samples, we are going to run a cation/anion column in order to make fractions of the protein through the use of charges. We will then identify the protein using mass-spec analysis.

Undergraduate Student

Molecular Surveillance of Fish Larvae Aimed at Investigating the Reproductive Ecology of Hypophthalmicthys molitrix in Tennessee Reservoirs

Primary Author: Alexus Jared[1], Biology

Advisor(s): Robert T. R. Paine[2]

Silver carp (Hypophthalmicthys molitrix) is a native eastern Asian fish that was introduced to the U.S. to control eutrophication in agricultural ponds in the 1970s. After escaping, silver carp dispersed via the Mississippi River and associated tributaries, causing threats to native biodiversity, loss of ecological function, and negative impacts to human recreation and economics. While juvenile (>100 mm) and adults have been documented, larval/fry stages have not yet been captured, nor has spawning or reproductive areas been identified in Tennessee reservoirs. Finding these spawning or nursery habitats will provide key information for resource managers to develop effective management strategies to help mitigate this invasion. Currently, captured larvae are identified using dichotomous keys and taxonomic expertise; however, visual identification is both time consuming and difficult due to incomplete keys or damaged individuals.

In place of these prior methods, molecular identification can be used to provide a more accurate and time-efficient approach to larval fish identification. We have devised an experiment to address three objectives related to molecular identification of silver carp larva in Tennessee reservoirs: (1) identify silver carp larva in mixed larva samples, (2) create a model that demonstrates the relationship between biomass and DNA concentration using quantitative PCR, (3) develop predictive modelling of silver carp spawning and larva presence in Tennessee reservoirs with environmental variables. Pending the results from our experiment, the information derived would aid resource managers in creating mitigation strategies for silver carp in Tennessee reservoirs.

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Undergraduate Student

Anatomical Diversity of Evolutionarily Convergent Egg Mimics in Passion Flowers (Passiflora L.)

Primary Author: Charis Littell, Biology

Co-Author(s)/Collaborators: Shawn Zeringue-Krosnick, Tennessee Technological University

Advisor(s): Shawn Zeringue-Krosnick

Passiflora (passion flowers) is a large genus well known for its morphological diversity and close associations with butterflies. Many Passiflora possess structures that mimic butterfly eggs, discouraging gravid butterflies from laying eggs, thus reducing the number of caterpillars that would feed on the plant. These structures are varied in form and position and have evolved independently many times. This study will document and compare the structural homology of egg mimic structures in the genus. Multiple examples of egg mimics were paraffin embedded and sectioned with a microtome and stained to differentiate among the types of egg mimics. Preliminary results suggest that at least four classes of egg mimics exist: those derived from aborted flower buds, the leaf apex, the stipule apex, and from abaxial nectaries. These structures are not homologous but instead represent convergence in creating a visual display that confers a significant advantage in decreasing herbivory.

Undergraduate Student

Assessing Phylogenetic Placement of an Undocumented Red-Burrowing Crayfish in the Tennessee River

Primary Author: Marc Mallinger, Biology

Co-Author(s)/Collaborators: Brooke Grubb; Jeffrey W. Simmons, Tennessee Valley Authority; Carla Hurt, Tennessee Technological University

Advisor(s): Carla Hurt

Crayfishes are a diverse freshwater group of crustaceans with over 450 species found in North America. This diversity is likely an underrepresentation given that many species are continually being described and several species represent species complexes. A particularly underrepresented group of crayfishes are within the burrowing species. Their burrowing behavior complicates sample collecting and many studies and surveys inaccurately portray community diversity. As a result, there are many undescribed taxa within burrowing crayfish. Investigators at the Tennessee Valley Authority discovered a previously undocumented red-burrowing crayfish within the middle Tennessee River watershed in Moore County, Tennessee. To assess the evolutionary and systematic placement of this novel taxa, we sequenced the mitochondrial COI and 16s genes and compared them to the Genbank and tissue sequences of morphologically similar species and subspecies. Our phylogenetic tree

analyses identified members of the Cambarus striatus species complex from nearby areas as a sister clade to the red burrower and indicated strong support for the novel red burrower to represent a distinct evolutionary lineage. Future analyses of nuclear single nucleotide polymorphisms (SNPs) will provide a better depiction of where the novel red burrower lies in its respective phylogeny as well as delineate the genetic boundary between the red burrower and members of the Cambarus striatus species complex.

Undergraduate Student

Riparian Wetland Nitrate Retention is Influenced by Both Floodwater Nitrate Concentration and Inundation Time

Primary Author: Andrew Rosson, Biology

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Justin Murdock

Nitrate is the most common form of nitrogen pollution in agricultural rivers. Excess nitrogen can cause harmful algal blooms and low oxygen levels in aquatic environments. Riparian wetlands in agricultural watersheds can be very efficient at removing nutrients before they reach streams and restoring agricultural wetlands for improving water quality has become a major focus of the USDA Natural Resource Conservation Service Wetlands Reserve Program (WRP). Our objective was to gain more understanding of how nitrogen concentration in flood waters impacts nitrogen uptake rates across different restoration types implemented by the USDA to restore these agricultural wetlands in the WRP. We collected 60 soil cores across four restoration types in a west Tennessee wetland. Cores were incubated in a continuous flow-through setup for 48 hours at 24Â°C with synthetic lab water, with 5 individual water sources of differing nitrate concentrations (0.1, 0.5, 1.0, 5.0, 10.0 mg/L). Each restorative type had 15 cores total, split up into 3 cores per nitrogen concentration. Results show that nitrate uptake varied over time with soil generally releasing nitrate initially and retaining nitrate after 24 hours. As well as nitrate uptake rates increased with more nitrate availability in all habitats. Wetlands can potentially be a source of nitrate when they are initially flooded but become nitrate sinks with a longer water residence time.

Undergraduate Student

Examination of Stylar Movement Among Floral Morphs in Passiflora incarnata L.

Primary Author: Kayla Sorensen, Environmental and Sustainability Studies

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Shawn Zeringue-Krosnick, Tennessee Technological University

Advisor(s): Shawn Zeringue-Krosnick

Passiflora incarnata is a widespread vine that is native to the Southeast United States and is most common in open sunny habitats along roadsides, riverbanks, thickets, and abandoned agricultural fields. It is also an important larval host plant to several species of butterfly and is pollinated primarily by carpenter bees. This species experiences a range of stylar movement after the flower opens in the beginning of the day, of which have been categorized into five different morphs based on their position at the end of the day. Relatively little is known about the stylar movement expressed in Passiflora incarnata. To further study the tissues involved in this movement, various specimens were observed using light microscopy. We focused our attention on the ovary apex junction, examining the transmitting tissue and vascular bundles as they move down the style and into the ovary. On the most functional and abundant morph, we saw inflated

cells on the abaxial side of the ovary apex junction, and deflated cells on the adaxial side; this leads us to suspect that an osmotic process is responsible for the movement. Several samples have been taken before and after the stylar movement to better understand the tissue structures and are currently being observed.

Undergraduate Student

A Comparison of the Bacteria on the Skin of Pantheropis obsoletus

Primary Author: Blaine Swieder, Mathematics

Advisor(s): Nikki Panter

There is a known antifungal bacterium that can be found on the skin of rat snakes, known as Morganella morganii, which was found on the skin of wild rat snakes (Pantheropis obsoletus) according to Hill et al. (2018). In this experiment, the goal was to see if rat snakes in captivity share the same bacteria as rat snakes in the wild. I used three different rat snakes in the Tennessee Technological University Herpetology Collection to de termine the bacteria. Following gel electrophoresis, successful rounds of bacterial colony PCR were sent to obtain a DNA sequence to determine the species of bacterium found by the microbial identification library. Af ter consulting the microbial identification library, I found the species of bacterium of the three rat snakes sampled from the Tennessee Tech Her petology Collection. From these findings, we can deduce that rat snakes in captivity may have the possibility to carry the same bacteria as wild rat snakes. With further study, we can see if any other snakes within the Tennessee Technological University Herpetology Collection contain Mor ganella morganii, and determine whether these bacteria are harmful or beneficial to captive and wild snakes.

Undergraduate Student

Phylogenetic and Geometric Morphometric Approach to Understanding Morphological Adaptations of the Major Chela in the Alpheus brevirostris Species Group

Primary Author: Katherine Torrance, Biology

Co-Author(s)/Collaborators: Anchita Sanan; Kristin Hultgren, Seattle University; Carla Hurt, Tennessee Technological University

Advisor(s): Carla Hurt

Alpheus is a spectacularly diverse genus of snapping shrimp that demonstrate a wide range of adaptations for diverse microhabitats. Traditionally, these shrimps have been categorized into seven morphological species groups using taxonomically informative characters such as the major chelae and the rostrum. A recent phylogenetic analysis of ~65 Alpheus shrimp revealed that five of the seven morphologically defined species groups, including A. brevirostris group, are not monophyletic. Species assigned to the brevirostris group can be distinguished from other species groups by their shovel-shaped major claw. Phylogenetic results reveal that this characteristic claw shape has evolved independently in multiple lineages; the independent origins of their characteristic chelae may be due to convergent evolution for a burrowing lifestyle. Here we use an integrated approach combining geometric morphometrics and molecular phylogenetic reconstructions to test the hypothesis of convergent adaptation for microhabitat. This project will serve as a model for understanding the evolutionary factors promoting morphological diversification of hyper-diverse marine lineages.

Undergraduate Student

The Genetics of Species Boundaries in Tennessee Woodrat

Primary Author: Lyndsey Wall, Biology

Co-Author(s)/Collaborators: Carla Hurt, Tennessee Technological University

Advisor(s): Carla Hurt

The Allegheny woodrat (Neotoma magister) and the Eastern woodrat (N. floridana) are designated as species of greatest conservation need in the state of Tennessee; populations have declined over the last 40 years due to loss of habitat and parasitism by the raccoon roundworm (Baylisascaris procyonis). The Allegheny woodrat and Eastern woodrat were thought to be parapatrically distributed across Tennessee, with N. floridana occurring south of the Tennessee River and N. magister occurring north of the Tennessee River up through Pennsylvania. However, the boundaries of their respective distributions are unclear as these two species are morphologically indistinguishable in the field and can only be differentiated by differences in skull morphology. There are also questions regarding potential hybridization between the two species where their distributions meet. The objective of this project is to determine the distribution of N. magister and N. floridana within the state of Tennessee and to assess geographic partitioning of genetic variation within each species. We used mitochondrial genes 16S, COI, and 12S to reconstruct phylogenetic relationships of Neotoma collected throughout the state. Results from this study will be used to design genome-wide SNP surveys for investigating potential hybrid zones and demographic histories.

Department of Chemistry

M.S.

Derivatization Methods for Perfluoroalkyl Substances (PFAS) by Gas Chromatography/Tandem Mass Spectrometry

Primary Author: Clement Aruada, Chemistry M.S.

Advisor(s): Andrew Callender

The perfluoroalkyl substances (PFAS) are environmentally persistent, non-degradable, bioaccumulative, and potentially harmful. These "forever chemicals" are widely distributed across the globe, and methods are needed for the rapid and routine analysis in a variety of matrices. Gas chromatography with mass spectrometry (GC/MS) is commonly used for the analysis of water samples, but PFAS compounds pose special problems in sample pretreatment, separation, and detection. Here, we present our work towards a sensitive, simple, and reliable analytical technique for the determination of perfluorocarboxylic acids (PFCAs) by GC/MS after amidation with 2,4-difluoroaniline (DFA). We report the optimized conditions for the synthesis of the derivatized analytes, as well as their GC retention properties and characteristic mass spectrometric fragments. The overall instrument detection limit is determined from a calibration curve study, and found to be acceptable for the analysis of surface water samples following appropriate solid-phase extraction and derivatization.

M.S.

A Novel Interaction between Apoptosis Signal-Regulating Kinase 1 (ASK1) and c-Jun N-Terminal Kinase (JNK)

Primary Author: Sekyere Boateng, Chemistry M.S.

Advisor(s): Xuanzhi Zhan

Mitogen-activated protein kinases (MAPKs) are a family of intracellular serine/threonine protein kinases that transmit extracellular stimuli to the machinery that controls fundamental cellular processes like growth, gene expression, differentiation, and apoptosis. MAPKs function sequentially in a three-tiered kinase module in which an upstream MAPK kinase kinase (MAPKKK) activates a MAPK kinase (MAPKK), which in turn activates the downstream MAPK. We recently discovered a previously unknown interaction between ASK1, the MAPK kinase kinase (MAPKKK) in the JNK cascade, and JNK3, the downstream MAPK. These novel interactions (ASK1 and JNKs) were studied using biochemical assays such as pull-down, kinase assay and western blotting. Our findings confirm the interactions between ASK1 and the JNK subfamilies (JNK1,2 and 3), with JNK3 isoforms binding ASK1 more strongly than the other two subfamilies. This resulted in the identification of a major ASK1 binding site in JNK3. The findings of this study will contribute to a better understanding of the assembly and function of multi-component MAPK complexes.

M.S.

Incorporation of Fluorinated-Tryptophan into c-Jun N-terminal Kinase 3

Primary Author: Brian Chong, Chemistry M.S.

Co-Author(s)/Collaborators: James Dethero; Jeffery O. Boles; William Carroll; Xuanzhi Zhan; Tylar Thompson

Advisor(s): Xuanzhi Zhan

c-Jun N-terminal Kinase 3 (JNK3) is a member of Mitogen-Activated Protein kinases (MAPK), which regulates a diverse signal transduction events related to

many essential cellular processes including differentiation, apoptosis and prefoliation. JNK3 has been recognized as a therapeutic target for neurodegenerative diseases, such as Parkinson's and Alzheimer's. This project seeks to elucidate the potential binding induced conformational changes of JNK3 protein by using 19F Nuclear Magnetic Resonance (NMR) spectroscopy. This study uses site specific incorporation of fluorine tags onto proteins through the use of chemically defined media, which seeks to deprive cells of the amino acid tryptophan. Through the addition of 5-fluoro-indole to the media, a fluorinated precursor to tryptophan, fluorinated tryptophan can be synthesized in cell by tryptophan synthase. For expression of JNK3 in this media, we will optimize the conditions by adding several nutrient additives (serine, and PLP) to increase the amount of fluorinated proteins. Our results demonstrate that the addition of serine and PLP significantly increases the production of functional JNK3. Preliminary NMR data indicates a successful incorporation of fluorine using this method of unnatural amino acid synthesis.

M.S.

Synthesis of pyridinyl-1,2,4-triazinyl-1,3,4-oxadiazole; A Soft-Lewis Basic Ligand Towards Selective Minor Actinide Extraction in Nuclear Waste Remediation

Primary Author: Fortune Dzeagu, Chemistry M.S.

Advisor(s): Jesse Carrick

Emission-free energy demand keeps rising as the impacts of global warming increase. Nuclear energy is one of the CO2-emission-free energies. However, nuclear waste management is the major challenge of nuclear energy production. Over the years, various nuclear waste management techniques have been employed towards nuclear waste remediation. In Selective Actinide Extraction (SANEX), one such techniques, nitrogen soft-Lewis basic ligands chemo-selectively separate minor actinides (An) from lanthanides (Ln). The An and Ln have similar physical properties posing challenges in their separation. Advance synthesis in this lab explored novel structurally diversified 2-(6-(5,6-(diphenyl)-1,2,4-triazin-3-yl) pyridin-2-yl)-5-(diversified) benzo-1,3,4-oxadiazole (MTP-1,3,4-oxadiazole) scaffolds to improve the performance of previously reported soft-Lewis basic tridentate ligands for minor An separation. This experimental effort focuses on condensation of mono-1,2,4-triazinyl pyridine (MTP) carbaldehydes with various diversified benzohydrazides. The resulting hydrazones were thermally cyclized to afford the desired 1,3,4-oxadiazole MTPs with 80-90% yields. The 1,3,4-oxadiazole scaffolds synthesized show intramolecular C-O cyclization via transition-metal-free iodide-mediated oxidation. Method optimization and preliminary synthesized scaffolds will be reported.

M.S.

Computational Design and Docking of Hamigeromycin B Natural Product Derivatives in 26 Human Kinases

Primary Author: Meagan Edmonds, Chemistry M.S.

Co-Author(s)/Collaborators: Derek Cashman, Tennessee Technolgical University; Jesse Carrick, Tennessee Technolgical University

Advisor(s): Derek Cashman

Hamigeromycin B analogs are synthetic natural product derivatives with potential for mediating signal transduction in human kinases. To study potential activity, 11 Hamigeromycin analogs were constructed using MOE 2020 and optimized using AMBER14:EHT. The analogs were docked into 26 human kinase structures obtained from the Protein Data Bank using the Docking module of MOE 2020. The docking sites in each kinase were targeted using the Protein Frustratometer and Evolutionary Trace to characterize the energetics and evolutionary importance of amino acids for contributions to binding. The lowest

binding free energy scores were used to determine the best binding and orientation of each analog. The data suggests that five kinases are potential targets. New compounds for study were computationally designed by modification of functional groups in the original analogs. All compounds were then subjected to further refinement using AM1 semiempirical quantum mechanics in Gaussian 09. The five kinases were all screened with a set of known HSP90 inhibitors, radicicol A and its derivatives. Functional group modifications were made to the radicicol compounds, and they were docked into the five kinases.

M.S.

Deep Eutectic Solvents: Effect of Pre-treatment of Biomass to Enzymatic Digestion

Primary Author: Emily Huntley, Chemistry M.S.

Co-Author(s)/Collaborators: Jeff Boles

Advisor(s): Jeff Boles

As the demand for greener fuel sources increases, renewable fuel sources are being studied. Biofuels obtained from cellulosic sugars in biomass sources are one such alternative fuel source. Due to the properties of cellulose and lignin in biomass, pre-treatment methods need to be conducted to assess the enzymatic access to cellulose. This study used deep eutectic solvents (DES) as a pre-treatment strategy to weaken the intermolecular forces between cellulose and lignin. DESs are prepared by mixing a solid state hydrogen bond donor and a solid state hydrogen bond acceptor yielding a liquid. Three DESs were synthesized with choline chloride serving as the hydrogen bond acceptor for each and urea, trifluoroacetamide, and oxalic acid serving as hydrogen bond donors. The biomass source, corn stover from Zea mays, was then incubated with each DES. Of the three synthesized DESs, the urea-choline chloride DES produced the best results when incubated with cellulase enzyme. Since the urea-choline chloride DES produced the most significant deconstruction, the DES was recycled and reused three more times to test its ability for reuse in subsequent incubations with fresh biomass.

M.S.

Investigating the In Vitro Transdermal Delivery of Liquid Asthma Drugs by Using Static Diffusion Cells

Primary Author: Jacob Thorn, Chemistry M.S.

Co-Author(s)/Collaborators: Andrew Callender, Tennessee Technological University

Advisor(s): O. Andreea Cojocaru

Active research into active pharmaceutical ingredient ionic liquids (API-ILs) began less than 25 years ago but has caught the attention of the scientific community due to the enhanced control of a drug's physicochemical properties that the API-IL strategy offers. Being able to modulate and enhance the various physical and chemical properties of an API allows for many advantages in drug design and development. One of the most promising features of API-ILs is the increased permeation affinity when a drug is converted from its standard solid state to a dual active liquid state pharmaceutical, potentially providing alternative routes of administration for APIs that were once limited to only one or two delivery methods. Through extensive chemical characterization, our research has indicated the successful synthesis of several albuterol and montelukast containing API-ILs. Using the static Franz diffusion cell technique, we aim to demonstrate the in vitro permeability of these novel compounds through a 0.01" thick silicone membrane in comparison to their corresponding standard solid-state forms.

M.S.

The Development of an Isoform-Specific JNK3 Inhibitor

Primary Author: Megan Wharton, Chemistry M.S.

Advisor(s): Xuanzhi Zhan

Mitogen-activated protein kinases (MAPK) are involved in a variety of signal transduction mechanisms as a response to a wide range of cellular stress stimuli. The ASK/MKK/JNK protein kinase cascade is involved in such signal transduction. The dysfunction of these cascades has been identified to impact downstream signaling effectors linked with the onset of neurodegeneration and cancer. c-Jun N-terminal kinases (JNK) are attractive therapeutic targets due to the rising interest in developing treatment for these diseases. Among the ten JNK isoforms (JNK1a/ÃŸ-1/2; JNK2a/ÃŸ-1,2; JNK3a-1/2), the two JNK3 isoforms' tissue distribution are near exclusive to the Central Nervous System (CNS). The objective of this work is to develop an isoform specific JNK3 inhibitor based on the structural protein interactions of JNK3 with its upstream kinases. Based on preliminary kinase assays comparing JNK3a2 and JNK2a2, it was supported that the novel Maltose Binding Protein (MBP)-fusion peptide inhibitor MBP-NJ40 was successful in isoform specificity in favor of JNK3a2. Another novel MBP-fusion peptide inhibitor, MBP-NJ20, was also investigated in its efficacy to inhibit JNK3a2. The half-maximal inhibitory concentration (IC50) of both MBP-NJ40 and MBP-NJ20 when analyzed were comparable to each other. This suggests that these inhibitors are successful novel candidates for controlled inhibition of JNK3a2.

Ph.D.

Geochemical Fingerprinting of Natural Waters in Tennessee

Primary Author: Bryant Davis, Environmental Sciences Ph.D.

Advisor(s): Andrew Callender

Geochemical fingerprinting is an analysis of the chemical species, present within natural waters, to determine both the source and alteration of these systems. These chemical fingerprints are defined as specific patterns of chemical species unique to each body of water. This research examines the presence of chemical species in surface waters that are located on two distinct physiographic regions of Tennessee: the Highland Rim and the Cumberland Plateau. Water bodies from these regions were chosen due to differences in local geology and land use patterns that each respective system are subjected to. Grab samples were obtained from various locations in order to obtain a true identity of each respective system. Multi variate analysis of variance (MANOVA) was then utilized to determine ratios of chemical species so that a comparative analysis could then be performed. These ratios of chemical species should indicate how local geology and land use patterns affect the chemical identity of natural waters within Middle Tennessee.

Undergraduate Student

Computational Design and Molecular Dynamics Simulation of Novel Inhibitors of Dihydrofolate Reductase in Three Bacterial Species

Primary Author: Allison Adams, Chemistry

Advisor(s): Derek Cashman

High affinity, small molecule inhibitors of bacterial dihydrofolate reductase (DHFR) were computationally designed to obtain broad-spectrum antibiotics against bacterial diseases B. anthracis (anthrax), S. aureus, and M. tuberculosis. Inhibitors were designed and optimized using molecular to target the active site of DHFR based

on computational analysis of the energetic frustration and evolutionary importance of amino acid residues present. The Protein Frustratometer (EMBNet, Argentina) and Evolutionary Trace (Baylor University, Houston, TX) were used for to define the active site, as they are useful in determining binding specificity, and areas of the molecule in high energetic states. The bonding residues were then compared to the areas of evolutionary trace and frustration to help identify the active site. 189 small organic molecules were designed to interact with these amino acids based on complementary, non-covalent functional group interactions. These compounds were examined according to Lipinski's Rules of Five, which helps to determine if a drug would be effective in humans. The most favorable candidates were identified and were analyzed through molecular dynamics simulations in order to verify and refine the results. The molecular dynamics simulations were conducted using NAMD v.2.9. (UIUC, Urbana-Champaign, IL) on Tennessee Tech's HPC cluster, and analyzed using VMD. 3D models of these compounds were printed using a 3D printer for conformational analysis.

Undergraduate Student

Cross-Species Molecular Docking of Ferredoxin into Photosystem I of T. Elongatus and Synechocystis sp. PCC 6803

Primary Author: Simone Atkinson, Chemistry

Advisor(s): Derek J. Cashman

T. Elongatus and Synechocystis sp. PCC 6803 are commonly used in the study of photosynthesis. The purpose of this research is to study the molecular interactions between the stromal domain (PsaC, D and E) of Photosystem I (PSI) and Ferredoxin (Fd) in a cross-species manner in order to optimize the electron transfer between the stromal domain and ferredoxin. Improving the electron transfer in these proteins should be able to aid in the design of potential biophotovoltaic energy cells for generating green electrical power. Computational models of PSI and Fd from the respective cyanobacterial species were obtained from the Protein Data Bank. The molecular docking software, ClusPro, was used to dock both Fd proteins into each stromal domain of PSI from T. Elongatus and Synechocystis sp. PCC 6803. 30 cluster centers were obtained and the amino acid residue contacts at the protein-protein interface were analyzed to determine which residues are important to binding. The results suggest that high affinity protein-protein structures are possible and the electron transfer distance can be improved when docking Fd from one species to another.

Undergraduate Student

Comparison of RAMAN Microscopy and ASAP Mass Spectrometry for Identification of Selected Fountain Pen Inks

Primary Author: Mia Campbell, Chemistry

Co-Author(s)/Collaborators: Andrew Callender

Advisor(s): Andrew Callender

There has been a rise of counterfeit and forgery crimes. For forensic purposes, research on fountain pen inks include identifying and distinguishing between samples. RAMAN spectroscopy analyses the vibrations of molecules and the spectra can act as a "fingerprint" for different fountain pen inks. A sample size of fourteen blue-black inks were analyzed. Ink spectra were added to an OMNIC database to compare and recognize similar inks to a certain confidence. It is anticipated that inks of the same brand or similar color will have a lower differentiation by the OMNIC software. If successful, the next phase will include a larger sample size with more brands. If inks are indistinguishable via RAMAN spectroscopy, inks will be diluted and compared to results from an ASAP Direct Mass Spectrometer.

Undergraduate Student

Progress Toward the Production of Capsaicin Analogs

Primary Author: Samuel Cartwright, Biology

Co-Author(s)/Collaborators: Emma Jones; Cody Strain; Daniel Swartling, Tennessee Technological University

Advisor(s): Daniel Swartling

Capsaicin and its analogues are useful in the field of analgesics to block nerve pain. Analogues of capsaicin are prepared by coupling vanillin amines and acid chlorides. The vanillin amines were synthesized by reacting the vanillin oxime with zinc and acetic acid. The vanillin oxime was produced from oxidizing vanillin with hydroxylamine hydrochloride and sodium acetate producing a high yield. The production of the vanillin oxime can be highly successful with these methods. The oxime is then used to produce the vanillin amine. The amine can be produced through different techniques, many were attempted. Once the vanillin amine is collected, it can be combined with an acid chloride to produce the capsaicin analogue.

Keywords: vanillin, vanillin oxime, vanillin amine, capsaicin

Undergraduate Student

Student Response to Supermarket Micro-column Chromatography Experiment

Primary Author: Lydia Cooke, Chemistry

Advisor(s): Chad Rezsnyak

Chromatography is an important laboratory skill utilized throughout the chemical disciplines. Often, the materials required can be prohibitively expensive or overly hazardous. In the present study, we present an optimized procedure for an introductory chemistry laboratory experiment which uses only reagents and solvents purchased from a supermarket, which had previously been described in the literature. The impact of the experiment on student understanding of chromatography and whether using common materials to perform an experiment improved their interest in chemistry will be discussed.

Undergraduate Student

Abiotic Generation of Floating Iron (Fe) Hydroxide Film with Rainbow Reflection: A Preliminary Hypothesis Testing Study

Primary Author: Carolyn Grace Cooke, Environmental and Sustainibility Studies

Co-Author(s)/Collaborators: Sydney Asmus; Kami Dunn; Zach Cord; Shawna Grey Coulter; Chance Morris, Tennessee Technological University

Advisor(s): Hong Zhang

Iron (Fe) is special. It is the last stable element generated in stars. Fe is also at the center of many chemical dramas involving ferric Fe (Fe(III)) and ferrous Fe (Fe(II)) and their reduction/oxidation (redox) staged in our environments. In a separate study, naturally occurring floating film with rainbow reflection observed on the surface of some natural waters was successfully regenerated in a laboratory setting (see the poster of Zac Rush and Zoe Penn). Here we report a laboratory study to test the hypothesis proposed in the separate study that the floating film is Fe(III) hydroxide polymer film generated by oxidation of Fe(II) (microbially produced at water/soil interface and released to water surface) to Fe(III) at water/air interface. Our study showed that the floating rainbow reflection film was successfully generated using inundated sand particles mixed with an Fe(II) salt in a beaker (as a simulation of the inundated soil systems). The study

further demonstrated that the floating film was successfully generated even in a simplest system of a beaker with the Fe(II) salt and water only. We also found that the amount of the floating film generated was dependent on the level of the Fe(II) salt and the level of free oxygen present in the water and headspace of the beaker. The evidences collected in this preliminary study jointly support the hypothesis on the natural phenomenon of the floating film involving a fascinating environmental redox drama.

Undergraduate Student

Utilizing 1H-NMR Spectroscopy to Measure the Octanol-Water Partition Coefficient of Hydantoin Compounds

Primary Author: Brayden Copeland, Chemistry

Advisor(s): O. Andreea Cojocaru

Solid-state drugs exhibit polymorphism (transformations between crystalline structures), negatively impacting their solubility, bioavailability, and overall efficacy. These changes can be prevented by transforming these drugs into an ionic liquid state. Hydantoin drugs were initially used as antiseizure and antiepileptic medications. After additional investigation, their topical use as a treatment for chronic wounds has shown promise. Their solubility impacts their efficacy in wound fluid. Previous research has shown that these compounds can successfully be converted into liquid state through the ionic liquid approach. Gaining insight into the dissolution rates of these compounds allows for new delivery pathways to be investigated. Their hydrophilic and hydrophobic properties can be determined by calculating the octanol-water partition coefficient (Kow). Here our efforts evaluating these properties through the use of 1H-NMR spectroscopy are discussed.

Undergraduate Student

Metal Ion Removal from Aqueous Solutions using NQSA SC and TSC Chelating Resins

Primary Author: Shawna Coulter, Chemistry

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

Advisor(s): Amanda Carroll

With the change of environmental impacts and pollutants, the amount of heavy metal ions found in water bodies have increased. These heavy metal ions pose risk to both the environment and humans because they can bioaccumulate in the environment. In order to remediate waters contaminated with heavy metals, a safe and effective removal process must be found. Napthoquinone sulfonic acid (NQSA) semicarbozone (SC) and thiosemicarbozone (TSC) ligands are attached to anion exchange resin beads to create chelating resins. The removal of two heavy metal ions will be studied using the chelating resins to determine their effectiveness at removing the ions from solution at two environmentally relevant pH values. A dry weight distribution, Dw, value is calculated to measure the amount of metal removed from the solution. It is anticiapted NQSA-SC and TSC resins will provide an effective means of remediating metal ions from aqueous sources.

Undergraduate Student

Synthesis and NMR Characterization of Metal Complexes of Butanedione-Monoxime Thiosemicarbazones

Primary Author: Huyen Dam, Chemistry

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

Co-Author(s)/Collaborators: Seth Crum

Advisor(s): Ed Lisic

Thiosemicarbazones are versatile organic compounds that have biological and medicinal properties; additionally, they act as multi-dentate ligands for metal complexes. Our lab has successfully synthesized a series of new monoxime-thiosemicarbazones ligands. Specifically, butanedione monoxime ethyl (BDMO-ETSC) and tertbutyl-thiosemicarbazone (BDMO-tBTSC) have been reacted with Copper(II), Nickel (II), and Palladium(II) salts to give a series of monomeric and dimeric complex structures. These structures were analyzed using NMR spectroscopy in order to characterize the monomeric and dimeric stages. The differences are discussed in our findings.

Undergraduate Student

Characterization of Binding-Induced Conformational Changes of Arrestin-3 Using 19F-NMR

Primary Author: James Dethero-London, Chemistry

Co-Author(s)/Collaborators: Brian Chong; William R. Carroll, Tennessee Technological University

Advisor(s): Xuanzhi Zhan

Arrestins, a small family of multi-functional scaffold proteins, play essential roles in G-protein coupled receptor (GPCR) signaling. Due to the many signaling pathways they are involved in, understanding arrestin structure and dynamics could be important for developing therapeutics for a variety of diseases such as Alzheimer's and Parkinson's. It is widely believed that arrestins undergo significant conformational changes to orchestrate their complex signal transduction processes. It remains a great challenge to explore these essential conformational movements induced by the binding of other signal molecules. This project seeks to better elucidate the mechanisms through which arrestin-3 mediates these signaling pathways with the use of 19F Nuclear Magnetic Resonance (NMR) spectroscopy analysis of interactions and conformational changes associated with binding known partners such as IP6 and kinases from JNK cascades, including ASK1, MKK4 & 7 and JNK3. Further, this study employs two different methods for 19F incorporation into arrestin-3: (1) unnatural amino acid (F-Trp) incorporation and (2) specific labeling on cysteine residues. Both methods can introduce the reporter molecules which contain fluorine into a desired location on arrestin-3. We are focusing on studying two residues: lysine 400 (K400) at the C-tail of arrestin-3 and phenylalanine 88 (F88) at the N-domain.

Undergraduate Student

Detection of Cadmium and Lead via Modified Glassy Carbon Electrode: A Study in Reproducibility

Primary Author: Kami Dunn, Chemistry

Advisor(s): Jonathan Moldenhauer

Trace amounts of heavy metals in local water supplies is a well-known threat to not only aquatic life, but humans as well. This ever-increasing problem makes monitoring trace heavy metals of extreme importance. Previously practiced and highly accurate monitoring utilizing mercury film electrodes and hanging mercury drop electrodes are now discouraged due to the toxic nature of mercury. A new, valid method of trace heavy metal detection has now been proposed using an internal standards method paired with a bismuth modified electrode via square wave voltammetry. This research aims for process optimization through the changing of the deposition time, use of convection, and establishing a new cadmium internal standard to make an extremely reproducible procedure. This research aims to show the elimination of acetonitrile, removal of dissolved oxygen, and an overall greener, highly reproducible alternative for trace heavy metal detection of cadmium and lead with the hopes of future use for other heavy metals.

Undergraduate Student

Molecular Modeling of Gas Hydrates

Primary Author: Matthew Evans, Chemical Engineering

Advisor(s): Subha Pratihar

Trapping of gas molecules is the essential step in surface chemistry. Interactions of molecules with ice surfaces are specially interesting for atmospheric chemistry. Experiments have suggested that different gas, like carbon monoxide, carbon-di-oxide, methane, nitrogen oxide, and ideal gasses like helium, xenon, krypton, etc, can penetrate ice and form a gas hydrate compound. This compound is defined as a gas molecule entrapped in a hydrogen-bonded water cage. Gas hydrates are abundant in deep water ocean sediments, near seafloor, in permafrost regions, and in interstellar mediums. In the current study we will consider different size water clusters (H2O)12-30 and entrapment of different gas molecules inside these clusters. We will investigate the structural deformation/reorganization of the water molecules in the water clusters by entrapment of different gas molecules. Matlab for coding, Gaussian for calculations and Avogadro for visualization will be used. Several different level of theory for calculation such as, MP2 and DFT (BLYP and/or B3LYP) and Pople type basis set such as, 6-31g** , 6-311++g** and/or Dunning basis sets, like cc-pVDZ, aug-cc-pVDZ etc will be considered for this research project.

Undergraduate Student

Anion Photoelectron Spectroscopy and Thermochemistry of Deprotonated Benzonitrile Isomers

Primary Author: Rebecca Firth, Chemistry

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

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Taylor Dimino

Advisor(s): Wilson Gichuhi

In this study, the negative ion photoelectron spectra of ortho, meta and para deprotonated benzonitrile anionic (o-,m-,p-C6H4(CN)Â¯) isomers as well as the corresponding thermochemical values of the o-,m-,p-C6H5(CN) isomers are reported. Quantum mechanical calculations based on density functional theory (DFT) with 6-311++G** and the aug-cc-pVQZ basis sets show that the o-,m-,p-C6H4(CN)Â¯ have electron affinity (EA) values of 1.901, 1.778, and 1.789 eV respectively. The computed Franck-Condon factors obtained using the PESCAL program results in o-,m-,p-C6H4(CN) vibrational structures that have several dominant active vibrational modes: a ring breathing mode around 1600 cm-1, a ring deformation mode at 630 cm-1 and a low frequency butterfly mode at 160 cm-1. Deprotonation at the ortho position gives a calculated gas-phase acidity value of 1600 kJ/mol. The calculated value is in close agreement with the previously reported high-pressure mass spectrometry experimental value of 1603.0 Â± 10.0 kJ/mol. The enthalpy of deprotonation of benzonitrile (?acidH298(C6H5CN)), the C-H bond dissociation energy (DH298(H-C6H4CN)), the ionization energy of Hydrogen (IP(H)) and the EAs of the o-,m-,p-C6H4(CN) radicals are related to each other through the negative ion thermochemical cycle:?acidH298(C6H5CN) = DH298(H-C6H4CN)+IP(H)-EA(C6H5CN). The EA values of the o-,m-,p-C6H4(CN) are therefore combined with the ?acidH298(C6H5CN) to obtain values for the C-H bond enthalpy of o-,m-,p-C6H5(CN) at 298K.

Undergraduate Student

Synthesis of Pharmaceutically Relevant Terpene Derivatives for Use as Topoisomerase Inhibitors

Primary Author: Taylor Fletcher, Chemistry

Co-Author(s)/Collaborators: Sydney Asmus

Advisor(s): William Carroll

Topoisomerase inhibitors play an important role in the fight against cancer. The focus of this research is to create a suite of pharmaceutically relevant terpene derivatives that can then be evaluated for usefulness in inhibiting topoisomerase. Multiple aldehydes have been chosen to be evaluated, all containing 19F. The targets of this work are terpenoids based on the diterpene carvone. The target molecules have synthetic handles that allow expansion to a known family of topoisomerase inhibiting diterpenes, the trachylobane family. While the inclusion of the 19F label here allows for the analysis of the protein interactions that these terpenoids participate in. The scope of this synthesis and the novel molecules produced were evaluated for reproducibility and usefulness in the inhibition of topoisomerase.

Undergraduate Student

Optimization of Annealing Temperature in Polymerase Chain Reaction on Constructing a Arrestin Variant (Arr3T137W)

Primary Author: Cooper Gasway, Chemistry

Co-Author(s)/Collaborators: Dominick Coker

Advisor(s): Xuanzhi Zhan

Polymerase chain reaction (PCR) is one of the most prevalent and effective methods implemented in cloning, sequencing, and DNA profiling. Among the three essential steps in PCR: denaturation (95 Â°C), annealing and elongation (72 Â°C), the annealing temperature could impact the amplification of the targeted DNA fragments. This experiment evaluated the effects of annealing temperature on PCR effectiveness and the optimal temperature for maximum yield and precision. To construct a single tryptophan arrestin3 variant, we intend to replace the Threonine with tryptophan by PCR. The effectiveness of this procedure was examined using agarose gel electrophoresis. This enabled comparison to previously effective PCR analysis, for sample identification and product conformation. The control sample at 46Â°C yielded an accurate and viable PCR product. A deviation of 10Â°C above or below the control temperature was conducted and analyzed via the same method. The sample at 36Â°C yielded results similar to the control. However, the sample conducted at 56Â°C yielded no product due to the annealing efficacy has been dramatically decreased at elevated temperatures. For the tested PCR reaction, annealing temperatures in the range of 36-46Â°C are effective, whereas temperatures are not effective.

Undergraduate Student

Women in STEM

Primary Author: Kiana Haynes, Chemical Engineering

Co-Author(s)/Collaborators: Iroda Abdullaeva; Subha Pratihar, Tennessee Technological University -Department of Chemistry

Advisor(s): Subha Pratihar

Like many issues regarding acknowledgment of women, there is a lack of appreciation and recognition for the women in Science, Technology, Engineering, and Mathematics (STEM). Despite all disparities, women have made tremendous progress in STEM education, research, and workspace during the past 50 years. Women in the past few centuries and in the current century have worked hard to earn their positions in STEM fields. In this research paper, the authors present some of the women scientists who have made notable contributions to their fields of study; significant women like Rosalind Franklin and

Andrea Ghez are mentioned. The authors compare recent, relevant data from Tennessee Technological University science departments of Chemistry and Biochemistry (undergraduate, masters, and graduate students as well as faculty) findings show that science students are 54% female and science faculty are 31% female. The rate of STEM courses taken by female students dop off significantly at higher education levels. The authors conclude by describing propositions to bridge the gender gap and increase women's representation and desire for STEM careers. Solutions include researching areas where women are less represented and increasing the amount of female role models for younger generations. Overall, there needs to be more educational and employment opportunities for women in STEM, and society today can make that change a reality.

Undergraduate Student

One Semester P-Chem as a Testbed for Integrating Course-Based Undergraduate Research (CUREs) Model to Conquer a Crowded Curriculum

Primary Author: Garrett Isham, Foreign Languages

Advisor(s): Wilson Gichuhi

A traditional two-semester physical chemistry (P-Chem) course covers major topics such as thermodynamics, chemical equilibrium, chemical kinetics, quantum mechanics, molecular spectroscopy, and statistical thermodynamics. On the other hand, a one semester P-Chem coverage involves a broad survey of the core topics with an in-depth treatment of selected topics depending on students' needs. In designing a one semester P-Chem course, the instructor must be keen to provide students with the required knowledge that is necessary to understand both the macroscopic and microscopic principles that govern physical and chemical behavior of matter. Whereas the choice of topics and coverage in a one semester P-Chem course is at the discretion of the instructor and the department, it is important that a fundamental P-Chem concepts are not overlooked. Specifically, students should learn about all aspects of P-Chem, the relationship between the two views, and the utilization of quantitative models that are critical in understanding and predicting the chemistry of small and large molecules. In this poster, we discuss the nature of a one-semester P-Chem course (Chem 3500) at TTU. We then present a preliminary pedagogical study (pilot) on this curriculum involving lab exercise.The ultimate goal of this pedagogical test is to investigate the efficacy of incorporating course-based undergraduate research experiences (CUREs) to enhance the course.

Undergraduate Student

Thin-Layer Chromatography Presumptive Test Kit to Qualify Cannabis Plant Material

Primary Author: Courtney LaPointe, Chemistry

Co-Author(s)/Collaborators: Jeff Boles, Tennessee Technological University Department of Chemistry

Advisor(s): Jeff Boles

The United States 2018 Farm Bill separated Cannabis production into two categories: marijuana and hemp. Clandestine marijuana is defined by more than 0.3% tetrahydrocannabinol (THC), and hemp is anything lower than that THC permitter. Cannabinoids are only identifiable at a molecular level which has become a problem for different agencies as the current presumptive forensic test kits can only test the presence of Cannabis. Developing a new presumptive test kit that can differentiate marijuana and hemp on a molecular level is pertinent to solving this issue for law enforcement and farmers both. Using thin layer chromatography (TLC), the plant material matrix is separated, and the individual cannabinoids are visible to the user. A polyester backed TLC plate, a moderately polar mobile phase and extraction fluid, and a

commercial water-soluble stain allows the kit to be used in rugged environments. Time and temperature studies were conducted to simulate the real-life conditions. The method used successfully differentiated the cannabinoids in seven lots of marijuana and fifteen lots of hemp by staining CBD as an orange color and THC as a red. The kit being rapid, cost efficient, and simple to operate creates an opportunity for any person to use it. The low cost is advantageous for rural law enforcement and farmers and furthers Tennessee Tech's Grand Challenge focusing on the development of rural areas.

Undergraduate Student

Development of a Law Enforcement Field Test for Identification of Opioid Surrogates Utilizing Thin Layer Chromatography

Primary Author: Claudia McDavid, Chemistry

Co-Author(s)/Collaborators: Jeff Boles, Tennessee Technological University Department of Chemistry

Advisor(s): Jeff Boles

Usage of heroin and cocaine is increasing as a surrogate to opioids. This increase has resulted in the increased use of presumptive drug test kits in the field by law enforcement; tests that simply rely on color change. This has led to an increase in the number of false positives, which has a negative effect to the public. Examples include the Scott's test for cocaine and the Marquis color test for heroin. Diluents, cutting agents and over-the-counter medications have shown to also give positive results for cocaine and heroin. This project's approach looks at stain reagents for cocaine and heroin as a presumptive use, but with a technique more common to definitive analysis, thin layer chromatography (TLC). A TLC kit would be run by law enforcement in the field. Preliminary studies have focused on silica TLC plates with cobalt (II) thiocyanate (cocaine and heroin), KMnO4 (heroin), and iodine (heroin) utilization for staining.

Undergraduate Student

Water Remediation Utilizing ISA, TSC, and SC

Primary Author: Chance Morris, Chemistry

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

Advisor(s): Amanda Carroll

Water contaminants have steadily increased as a health and environmental hazard. In 2021, the EPA has regulated over 90 water pollutants under the National Primary Drinking Water Regulations (NPDWR). For the purposes of this project, heavy metal ions will be studied. According to the EPA, some of these ions have contributed to increased risk of cancer, liver and kidney damage, allergic dermatitis, and more. This project focuses on the removal of heavy metal ions from aqueous sources using Isatin sulfonic acid (ISA) thiosemicarbazones (TSC) and semicarbazone (SC) chelating resins that are immobilized onto resin beads via anion exchange. These chelating resins are stirred in solutions at environmentally relevant pH values containing selected metal ions. The metal concentrations prior to contact with the resin and after contact are used to calculate a dry weight distribution value (Dw) to determine the effectiveness of removal by the resin of choice. It is anticipated that these resins will be successful at removing the metal ions of interest and hold the potential to become a contributing step to healing the environmental world.

Undergraduate Student

Synthesis of Structural Colorants via Silane Functionalization of Reactive Pigments

Primary Author: Andrew Nguyen, Chemistry

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

Advisor(s): William Carroll

The formulation of new colorants that are both inherently colorfast and stable is an active area of research. By utilizing tetraethyl orthosilicate (TEOS) to form shells around colored substrates they may be enhanced with a greater reflective ability resulting in an iridescent effect. The size of this particle can contribute to the refraction of light of a similar wavelength to produce a structural coloration. The Stöber process was used to produce glass nanoparticles that refract blue light. When dried on top of black carbon media, the nanoparticles aggregate in layers and are visibly bluer than when dried on clear media. With the manipulation of the size of the particles and substrate the nanoparticles are deposited on, a range of semi- to truly iridescent colors can be created. By modifying the Stöber process to incorporate different functionalized silanes and pigments, this work explores the creation of more stable and vibrant colorants.

Undergraduate Student

Chemoselective Green Oxidation of Heteroaryl Isoprenes Toward Functionalized Methyl Ketones

Primary Author: Connor Pinson, Mathematics

Co-Author(s)/Collaborators: Alexander Stovall; Zachary Gulledge

Advisor(s): Jesse Carrick

In the search for green and renewable energy sources, nuclear energy has become a source of interest. Although nuclear energy has a small carbon footprint, it produces spent nuclear fuel (SNF). With the goal of selective separation of specific daughter nuclides from SNF, prior work focused on symmetrical examples, bis-[1,2,4]-triazinylpyridines, which showed chemoselectivity for actinides over lanthanides. Currently, the project's goal is to synthesize and purify functionalized methyl ketones for downstream cyclizations. Common acylation methods do not give the desired product when pyridines were present. The group utilized a Suzuki-Miyaura cross-coupling reaction for the addition of the isopropenyl group which undergoes a green oxidation to afford the methyl ketone. This method leverages potassium permanganate as the oxidant along with sodium paraperiodate resulting in the desired products. These ketones will be used for downstream cyclization toward 1,2,3-triazolyl pyridines. Applications, synthetic methods, substrate scope, and downstream functionality will be presented.

Undergraduate Student

Diffusion Behavior of Liquid State Aliphatic Phenothiazine Compounds

Primary Author: Diana Popa, Chemistry

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

Co-Author(s)/Collaborators: Eva E. Etheridge

Advisor(s): O. Andreea Cojocaru

Ionic compounds are high melting compounds comprised of cations and anions held together through electrostatic interactions. When these ionic compounds contain either an organic cation or anion they tend to melt below 100 ^{o}C and they are referred to as ionic liquids (ILs). Double salt ionic liquids (DSIL) are complex ILs with either one anion and several cations, several anions and one cation or several anions and several cations. Both the ILs and DSILs have important applications in drug design as they will keep the pharmacological properties of the constituent ions while having improved properties (such as bioavailability and aqueous solubility) when compared to the corresponding neutral precursors. Thus, by modifying the ionic composition and molar ratio, one can easily formulate new ILs and DSILs with specific purposes. One

powerful technique for characterizing these liquid state compounds is diffusion-ordered spectroscopy (DOSY). When applied to ILs and DSILs, DOSY measures the self-diffusion coefficients for the constituent anion(s) and cation(s). The work presented here focuses on using DOSY to determine the diffusion behavior of several DSILs obtained by combining aliphatic phenothiazine cations (promazine, chlorpromazine or trifluprom azine) with two anions, namely the ibuprofenate (a known non-steroidal anti-inflammatory drug) and docusate (a penetration enhancer) anions.

Undergraduate Student

Microbially Mediated Generation of Floating Iron (Fe) (oxy)hydroxide-oxide Film in Inundated Soils: A Preliminary Laboratory Study

Primary Author: Zachary Rush, Chemistry

Co-Author(s)/Collaborators: Zoe Penn

Advisor(s): Hong Zhang

Iron (Fe) is ubiquitous in soils and waters. Fe has two reduction/oxidation (redox) species commonly found in the environments, i.e., ferric iron (Fe(III)) and ferrous iron (Fe(II)). Fe(III) species are insoluble, existing as hydroxides (Fe(OH)3), oxyhydroxides (FeOOH), and oxides (Fe2O3), while Fe(II) is soluble and mobile. Previously, naturally occurring oil-like film with rainbow reflection was observed floating on the water surface of some wetland (Michigan) and some shallow inundated soils/sediments (Cookeville, TN). Here we report a laboratory study to generate the oil-like film at the water surface of inundated soils collected from various places of City Cookeville (TN) in a laboratory setting (beakers with inundated soils). Our study demonstrated that the film was initially a colorless thin layer the same as the naturally occurring film previously observed and it transformed to a thicker film and then to orange/red crust over the time. The study also showed that the generation of the floating film was microbially mediated. This study supports the hypothesis that the generation of the film involves a redox drama of microbially mediated reduction of Fe(III) oxides to soluble Fe(II) at water/soil interface followed by an oxidation of the Fe(II) (released from the soils) at water/air interface and the nature of the initial colorless rainbow reflection film is inorganic Fe(III) hydroxide polymers, which further transform to Fe(III) oxyhydroxides and then to Fe(III) oxides.

Undergraduate Student

Towards Transdermal Delivery of Thioridazine Double Salt Ionic Liquid Drugs

Primary Author: Claire Rust, Chemistry

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): O. Andreea Cojocaru

Thioridazine is a solid-state phenothiazine drug taken orally to manage symptoms of schizophrenia. Aside from its intended purpose, thioridazine also causes severe cardiac arrhythmias. Typically available as a solid, thioridazine's structure allows various crystalline structures (polymorphism) to exist with different or no pharmaceutical activity. By combining thioridazine cation with lidocaine cation (an antiarrhythmic agent) and docusate anion (a penetration enhancer), this drug can be converted into a double salt ionic liquid (DSIL). This strategy would provide a new pharmaceutical with higher bioavailability and an absence of polymorphism. Furthermore, the liquid state drug can be delivered across the skin and transported into the systematic circulation through transdermal delivery, providing patients with different, painless delivery options. This proposal focuses on investigating the transdermal delivery potential of thioridazine DSILs through a skin-mimicking silicone

membrane and into phosphate buffer saline, a buffer that mimics blood's ionic composition.

Undergraduate Student

Development of Field Test for Identification of Cocaine with TLC

Primary Author: Emma Schrider, Chemistry

Co-Author(s)/Collaborators: Jeff Boles, Tennessee Technological University Department of Chemistry

Advisor(s): Jeff Boles

Currently used as a presumptive field test for identifying cocaine, the Scott's test has been shown to bring false positives as heavily relied on evidence. While some precautions have been taken, there are still too many variables that affect the outcome, including presence of similar drugs, diluents and mass sensitivity. This project's approach looks at the same stain reagent in a different form, a thin layer chromatography (TLC) kit, rather than a presumptive test kit like that sold by NIK. Even though more complex, design has focused on the ability to carry out the test in the field by law enforcement. The optional use of a heat source for enhanced color development has also been included in this study. Preliminary studies have focused on silica TLC plates, cobalt (II) thiocyanate stain, and a mobile phase with a 8:1:1 ratio of ethanol, methanol, and ammonia.

Undergraduate Student

Hair Analysis: an Investigation into its Scientific Validity

Primary Author: Kyle Schulmeister, Chemistry

Co-Author(s)/Collaborators: Jeff Boles, Tennessee Technological University Department of Chemistry; Jonathan Moldenhauer, Tennessee Technological University

Advisor(s): Jeff Boles

Hair analysis has been a widely used forensic technique since the mid-20th century. One of the most common sources of evidence in a crime scene is from hair. As such, hair analysis has been used to convict many. This method is flawed, however. There has not been a consistent set of criteria for comparison, and no scientific knowledge of the frequency of occurrences of certain characteristics in hair. As a result, this technique has fallen under controversy in the past few decades. This project aims to investigate the forensic technique of hair analysis through a variety of means. In particular, the history of its use, the science behind it, its flaws, and its use in the present day will be examined. In conducting this study, one can identify issues and suggest methods to improve the scientific validity of hair analysis as a technique.

Undergraduate Student

Synthesis of Bioactive Juglone Compounds Via Aromatic Ammonium Cations?

Primary Author: Hayden Suddeath, Chemical Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

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

Advisor(s): Twanelle Majors

Juglone is an organic compound with remarkable chemical properties found in substantial amounts in walnut hulls. In agriculture, the herbicidal capabilities of walnut hulls

have been overlooked. The selectively toxic characteristics of juglone present sustainable, environmentally conscious routes for the management of undesired plants or fungi. The herbicidal potential of juglone is hindered by its low water solubility (it lingers in soil) and high volatility (poses a risk to exposed workers), reducing its efficacy for current herbicidal applications. Toxicity to various common cash crops and freshwater organisms used as a food source by fish is a concern due to the risk of the compound gradually drifting to non-target areas.

This presentation shows our efforts toward applying the ionic liquid strategy for the synthesis of new Juglone derivatives with varying degrees of mobility. Juglone anion is paired with several quaternary ammonium cations of various hydrophobic character, and the new compounds are characterized using spectroscopic techniques.

Undergraduate Student

Of Rosin Materials Towards Pharmaceutical and Environmental Purposes

Primary Author: Hannah Sudekum, Chemistry

Advisor(s): O. Andreea Cojocaru

Industrial environments are found across the world, and have directly contributed to the increase in factories as a result. However, there are also serious issues that have arisen from these industries, with major concerns pertaining to their toxic vapors, wastes, byproducts, and water contamination by metals (mercury and lead).The best option to remove these metals is to use an environmentally conscious ligand; one option is to use a bio-renewable, biodegradable, and environmentally friendly material to bind and extract metals from various materials. Other concerns include drawbacks from the pharmaceutical industry such as poor water solubility and dissolution rates of many drugs. One way to address this issue is by using the prodrug strategy.

An FDA approved material Rosin, a binder for pharmaceutical tablets, can be used to address both of the aforementioned issues; the main component is a carboxylic acid (abietic acid) and can form esters with hydroxy-comprised compounds (imidazole-thiones or hydroxyl groups). The produced esters can form metallic complexes with heavy metals (imidazole-thione materials) or deliver a drug into an aqueous environment (through a prodrug strategy). In addition, the hydrolysis of the rosin esters will allow for its recovery. Here, we present our efforts towards developing such rosin esters as bio-renewable, biodegradable ligands for removal of heavy metals from the environment, and as potential drug delivery systems.

Undergraduate Student

Synthesis and NMR Characterization of Mixed Oxime Thiosemicarbazones and their Metal Complexes

Primary Author: Bailey Talent, Chemistry

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

Advisor(s): Ed Lisic

Thiosemicarbazones are a class of organic compounds that function extremely well as ligands that bind to transition metals to form metal complexes with interesting biological properties. This presentations focuses on synthesis and characterization of a new series of monoxime thiosemicarbazone. Two new compounds, namely a-isonitrosacetophenone ethyl thiosemicarbazone (INAP-ETSC) and a-isonitrosacetophenone tert-butyl thiosemicarbazone (INAP-tButyl), are synthesized and characterized by Nuclear Magentic Resonance Spectroscopy (NMR). The synthesized compounds were further used to create metal-ligand complexes that will be tested for their anticancer properties by studying the inhibition of topoisomerase IIa.

Undergraduate Student

Negative Ion Photoelectron Spectroscopy of 1,4-Anthraquinone and 9,10-Napthaquinone Anions

Primary Author: Nolan White, Chemical Engineering

Co-Author(s)/Collaborators: Aidan Usher

Advisor(s): Wilson Gichuhi

The resonant attachment of low energy electrons (i.e. energies less than 1.7 eV) to 9,10-anthraquinone (AQ) and 1,4-anthraquinone (NQ) molecules in the gas-phase has previously been found to give rise to the formation of long-lived molecular anions. Although the nature of the associated long-lived anionic species have previously been studied using the negative ion mass spectrometry technique, the deprotonated form of the anion have not received much attention. In this poster, we lay ground for planned negative ion collision induced dissociation (CID) and density functional theory (DFT) quantum mechanical calculation studies on AQ- and NQ- by looking at the negative ion spectra of HSO4 and SO4 anions. Using previous electron spray ionization (ESI) and Ultraviolet (UV) photodetachment data, we perform a more detailed vibrational and Franck-Condon (FC) anaysis of the resulting HSO4 and SO4 neutral radicals to determine the active vibrational modes. These FC simulations are based on a harmonic oscillator approximation model that utilizes the Duschinsky rotation between the normal mode vectors of the anion and neutral. Insights from these vibrational analysis will be utilized as a starting guide towards understanding the role of O- ion on the negative ion photoelectron spectra of deprotonated AQ- and NQ-. The collison energy dependent studies of AQ- and NQ- will be interpreted with the support of quantum mechanical calculations and Franck-Condon analysis.

Undergraduate Student

Negative Ion Photoelectron Spectroscopy of Deprotonated Nitrobenzene and Dinitrobenzenes

Primary Author: Kie Workman, Chemical Engineering

Advisor(s): Wilson Gichuhi

Due to their sufficiently large dipole or quadrupole moments, nitrobenzene (NB) and dinitrobenzene (DNB) anions have been found to form long-lived valence anionic states. As a result, previous Rydberg charge and/or photodetachment experimental studies heavily focused on identifying the nature of the resulting long-lived anions, which are relatively highly unstable. Although the deprotonated anions of these molecules are expected to be stable, no work has been done to determine the vibrational structure of the deprotonated neutral, following photodetachment. In this poster, we utilize a harmonic model in the Franck-Condon (FC) analysis of the vibrational structure of the radical resulting from the negative photoelectron spectroscopy of NO2- as a simple example to understand how the strong withdrawing NO2 group might affect the vibrational spectra of deprotonated NB and DND. The NO2- spectra are interpreted based on the comparison with quantum-mechanical data obtained from ab initio calculations as well as the Franck-Condon (FC) simulations. Plans are underway to perform collision induced dissociation experiments as well as quantum mechanical density functional theory (DFT) calculations on deprotonated NB and DNB anions in order to get insights on the resulting vibrational structure of the neutral radical.

Undergraduate Student

Creating 3D-Printed Anisotropic Media for Use in Nuclear Magnetic Resonance

Primary Author: Elizabeth Yielding, Chemistry

Advisor(s): William Carroll

Various Nuclear Magnetic Resonance (NMR) techniques contribute to the determination of protein and small molecule structures. The use of Residual Dipolar Couplings in structural determinations requires a specialized anisotropic media based on solvated gel polymers. They typically take weeks to be ready for use and when combined with limited suppliers using these polymers can be costly. A 3D printed polymer substitute reduces cost and can vastly reduce the time between product creation and testing. The objective of this project was to create a 3D printed orienting media that contains many microscopic channels, allowing for the suspension of analyte molecules in an anisotropic environment. A 3D model file was created and produced in a resin 3D printer to create candidate orienting media. These were then used to obtain several NMR spectra in deuterated chloroform. Optimal solvent wash conditions were determined to avoid polymer cracking; pore size dimension and polymer compression were also explored to determine their impact on the orienting effects as measured in NMR. Moving forward, 3D printed polymers demonstrate promise as an alternative orienting media.

Undergraduate Student

Synthesis of 5-fluoroisatin and 7-fluoroisatin Thiosemicarbazone Ligands

Primary Author: Emma Zachary, Biology

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

Co-Author(s)/Collaborators: Bailey Talent

Advisor(s): Ed Lisic

Isatin thiosemicarbazones have been known for a long time to have biological properties such as in the production of anti-tuberculosis drugs. Recently they have been used in the synthesis of metal complexes. We have investigated the synthesis and characterization of the 5-fluoroisatin and 7-fluoroisatin thiosemicarbazones. This poster presents information on synthesis and NMR characterization of the ligands to form Pd(II) complexes.

Undergraduate Student

Synthesis of a Novel Terpenoid and Optimization of Its Preparation for Yield and Environmental Impact Using Design of Experiment (DOE)

Primary Author: Sydney Asmus, Chemistry

Co-Author(s)/Collaborators: Taylor Fletcher

Advisor(s): William Carroll

The use of certain solvents in chemical reactions can cause negative environmental impacts. The goal of this work is to synthesize a novel terpenoid for use as topoisomerase inhibitors and optimize this synthesis for both yield and environmental impacts. The reactions are analyzed by a green scoring software, DOZN, that provides a quantitative scoring of its environmental impact. This research optimized a green reaction on the microliter scale using design of experiment (DOE) procedures with nuclear magnetic resonance (NMR). The reporting of the synthesis of a terpene derivative including an F19 label and the optimization of its synthesis using DOE for its ideal DOZN score. A standard procedure optimizes multiple reactions while also remaining fiscally competitive with non-green alternatives.

Undergraduate Student

Constructing a Single Tryptophan Arrestin-3 Variant A3V9W by Site-Direct Mutagenesis

Primary Author: Kayla Gipson, Chemistry

Co-Author(s)/Collaborators: Xuanzhi Zhan; Lauren Cope

Advisor(s): Xuanzhi Zhan

To study the potential binding-induced conformational changes on arrestin-3, a multifunctional adaptor protein, we intend to incorporate a fluorinated tryptophan residue as reporter in this protein, then obtain the fluorine NMR spectroscopy of this protein. A3V9W variant was designed to place a single tryptophan residue at the N-terminal of arrestin-3, which was reported as a primary binding site for some arrestin-3 binding partners such as JNK3 and ERK1/2. Here, we report our efforts to construct this arrestin-3 variant expression plasmid (pTrc HisB) by site-direct mutagenesis.

Department of Earth Sciences

PSM

A Method for Mapping Environmental Justice Factors by Watershed

Primary Author: Madison Moffitt, Environmental Informatics PSM

Advisor(s): Peter Li

Environmental justice (EJ) is defined by the Environmental Protection Agency (EPA) as the fair treatment and meaningful involvement of all people regardless of race, color, national origin or income concerning the development, implementation, and enforcement of environmental laws, regulations and policies. Since the rise in awareness of EJ issues in recent years, our government has declared it essential to identify and address infrastructure problems of communities with EJ concerns. While the EPA has created an Environmental Justice Screening and Mapping Tool (EJSCREEN) to aid in identifying those communities, it contains limited EJ indicators and can only assess how communities are affected at the census tract level. This project aims to map watersheds and quantify their relative EJ factors alongside environmental factors to understand better their influence on communities. Using ArcGIS, our goal is to develop a spatial and statistical methodology for use as an environmental justice tool for watersheds in Tennessee. The findings from this study can provide state and federal governments with a tool to understand how EJ and environmental factors interact within their communities and watersheds.

Undergraduate Student

Microstructures in Faulted Sandstone near Spencer, Tennessee

Primary Author: Joel Baker, Geosciences

Co-Author(s)/Collaborators: Alyssa Oldfather; Holly Stripling; Michael Harrison

Advisor(s): Michael Harrison

Road construction along State Route 111 north of Spencer, Tennessee exposed 150 meters of fresh outcrop of Pennsylvanian Sewanee Conglomerate. Here, the Sewanee is a 40-meter thick cross-bedded conglomeratic quartz sandstone that is yellowish-gray to 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. Fault-damage zones of white friable cataclasite occur in proximity to closely spaced strike-slip faults. These zones may represent internal deformation of the regional Cumberland Plateau overthrust. Point-counting analysis of nine samples collected from the outcrop reveals that pressure-solution microstructures are the most common microstructure, affecting nearly 95% of the quartz grains. Microcracks, representing brittle deformation microstructures, affect 25-52% of the grains and are most abundant in fault-damage zones. Cataclastic bands are localized zones of intense brittle deformation and are associated with faulting. The assemblage of microstructures indicates that rock deformation during the Alleghanian orogeny occurred at low temperature (<300Â°C) and shallow depth (<10 km).

Undergraduate Student

Communicating Climate Change: Boundaries Between Scientists and Public Acceptance

Primary Author: Gabrielle Burke, Geosciences

Advisor(s): Lauren Michel

Though there is consensus among climate scientists that anthropogenic climate change is happening, public polling does not show the same consensus due to variables like conflicts with personal values or misrepresentation of academic views. The interest of our research was to analyze how scientists communicate global warming findings and determine ways to improve effectiveness. A literature study focused on the overlap of personal values and trust in climate change claims. Results show that individuals will not want to engage in dialogue if they feel that their values are criticized. Values like economic views, religion, experience, and culture are all relevant to views on climate change. A scientific consensus does not translate into acceptance of the issue or policy shifts when portions of the population do not value the basis of the studies. We have found that there is often false controversy from inadequate discourse, a foundational distrust of institutions, and false speech from admired parties. Combating this requires a separation of academia from those within it, so conversations about societal issues are between equally affected citizens. The conclusion is that we cannot respect consensus or accept a contrary idea if we do not respect the origins of the information. To have productive dialogue with a member outside of an academic community like climate science, the focus of the conversation must be a connection in values to the individual's experience.

Undergraduate Student

Dissolution and Recrystallization of Disarticulated Crinoids in Fort Payne Formation (Mississippian), Tennessee

Primary Author: Dominic Campoli, Geosciences

Advisor(s): Jeannette Luna

The Fort Payne Formation is a 320-million-year-old unit of rocks containing limestones, shales, and other sedimentary rocks. One of the main components of this formation is a crinoidal packstone, a biochemical sedimentary rock that is grain-supported and has more than 10% matrix material. The crinoid fragments within this unit show petrographic signs of dissolution, and recrystallization as quartz and/or calcite. Field samples taken on the TN Highway 52 near Celina, TN have been processed into thin sections for microscope work, which have been analyzed to observe the evidence of recrystallization of silica in these normally calcite rich fossil fragments. Five thin section slides from different parts of the Fort Payne have been studied, specifically where crinoid fragments above .5 mm in size occur. Here, we observe that recrystallization of silica only happens in specific parts of the crinoid fragments, and more importantly, the process of silica recrystallization happens as multiple phases of growth. There are two phases observed; A coarser grained internal phase, and a finer grained phase that remains adjacent to calcite growths. By using cross-cutting relationships, the order in which these phases of crystallization and dissolution occurred in can be more accurately charted chronologically.

Department of English

M.A.

Queer Storytelling in S-Town: An Analysis of the Use of Queerness in Podcast Production

Primary Author: Lena Albro, English M.A.

Advisor(s): Brian Williams

In 2017, a podcast called S-Town took the world by storm and became a viral hit with several million downloads during its first week. The podcast follows the host, Brian Reed, on his excursion to rural Alabama, where John B. McLemore asked him to investigate a potential homicide. Instead of a homicide, however, McLemore turns into the polarizing subject of the podcast himself, as he personifies the intersection of queerness and Southerness, captivating the audience while disrupting Southern heteronormativity.

In this paper, I argue that Reed and the production team of S-Town revolutionized the art of storytelling in podcast production by queering the medium, ultimately satisfying the public's need for more authentic stories. I analyze how the podcast achieved its unprecedented success by using queerness and queer worldmaking techniques to construct McLemore's queer identity, all while using novelistic strategies and a rhizomatic narrative structure with unpredictable directions typical for queer worldmaking. Finally, I question Reed's role in the creation of the podcast to examine how he is driving the queer narrative around McLemore while entering a homosocial, codependent relationship with him.

I discovered S-Town originally in PC 5970 Professional Communication II, and decided to conduct further research and analysis on this podcast in ENGL 6000 Introduction to Graduate Studies, for which I ultimately wrote this essay.

M.A.

Fanny Hill: An Eighteenth Century Bisexual Woman

Primary Author: Hayle Moore, English M.A.

Advisor(s): Helen Hunt

What exactly counts as "sex"? John Cleland's Fanny Hill: Memoir of a Woman of Pleasure (1748) works to answer this question even as it, of course, titillates its readers. Fanny Hill's conception of "sex" is fundamental to modern conceptions of sexuality. Not only was it the first pornographic novel written in English, read widely in the three centuries since its initial publication. The novel grapples with the concept of sexual desire and related paradigms of consent. To do so, it suppresses homoerotic pleasures it displays through sexual scenes, emphasizing the idea that homoerotic relationships are less satisfying than penetrative heterosexual sex.

In the text, Fanny feels desire for and has sexual relations with both men and women. However, the novel never considers her homoerotic relations "sex". Instead, the women who engage in this type of pleasure describe the events as acts of masturbation or mutual masturbation if they are with women and "sex" only if a penis comes into play.

Situations that would be labeled as rape today, are portrayed in a way that suggests that women consent by being women are available for intercourse at the time the men desire it. These two paradigms work together to limit the control that women can exercise over their sexuality. I use Michel Foucault's History of Sexuality to explain how Fanny Hill relates to changing definitions of women's sexuality and suggest that the novel displays a bisexual erotic experience.

M.A.

Adventure into the Forest: An Ecocritical Analysis of the Grimm Tales

Primary Author: Brian Radford, English M.A.

Advisor(s): Brian Williams

In their fairytales, Jacob and Wilhelm Grimm depict nature as dualistic, a menacing place full of exotic creatures, witches, and fantastical elements. They explore cultural explanations of nature as dealing with both the dangers and wonders found within the veil of forests. Often discussed amongst ecocritical scholars as presenting either a utopian ideal or a perilous place, the Grimm tales depict a correlation of both extremes by examining the extraordinary chaotic world in nature. This duality alludes to both the fears of the unknown and the hidden fantastical creatures or magical witchcraft found within. The view of chaos in nature can explore the fantasies of children's imagination and dangers beyond the safety constructs found in modern society.

This paper offers an ecocritical perspective of the Grimm's tales to analyze their representation of nature as both a utopian ideal and a perilous environment of death and witchcraft. The intersection of this binary provides an understanding of the concerns dealing with the unknown chaos found in nature. In the forest lies both awe and mystery for the characters to explore in specific Grimm tales. I argue the use of this motif in fairy tales takes the reader from the structure of society into the chaotic world within the forest where magic and wonder preside. This duality construct allows our curious minds to interpret the inner fight or flight when approaching the natural world as presented in the Grimm children's stories.

M.A.

Identity and Experience: The Binaries of The Sonnets

Primary Author: Hannah Cole, English M.A.

Advisor(s): Brian Williams

Building upon other theorists' analyses of a queer presence in Shakespeare, this paper considers the relationship between poet and muse. If viewed as an early representation of fluidity, the poetic voice within the sonnets become a vehicle for gender exploration as well as free flowing sexuality and sexual orientation. Paying special attention to the constantly shifting gender of the sonnets, the poet and the muses are able to exist on a spectrum. The absence of a definite label, the allowance to just exist as queer without qualifier, brings Shakespeare's collection forward and within modern considerations of self-exploration. It is exactly the lack of concrete identity that draws away from the insatiable urge to label queerness. By analyzing a selection of sonnets, this paper aims to explore both vocabulary and structure as they apply to the spectrum of identity and infatuation the sonnets' speaker experiences. Allowing identity to stand for expansive possibility rather than binding categorization, this exploration reconsiders the power dynamic at play within Shakespeare's sonnets and how it challenges the accepted gender binary.

Undergraduate Student

The Toiling Effects of Being "Borne Back Ceaselessly into the Past": A New Critics Analysis of The Great Gatsby

Primary Author: Daniel Crabtree, English

Advisor(s): Josephine McQuail

The Great Gatsby by F. Scott Fitzgerald is a timeless masterpiece of American literature. Although the events that the characters endured are long past, the emotions that they stir within the human conciseness have been preserved by every reader in the past 96 years. Factors such as war, love, and selfishness are defining things that shape the characters, and in turn, the world that surrounds them. Throughout this literary critique, I closely examine the text of the novel to connect all the different aspects of Fitzgerald's masterpiece to a single underlying theme of nostalgic longing. Within the analysis, I connect the theme with many of the important characters to reveal how their questionable actions could be explained. Additionally, I connect the theme to the novel's symbolism to create a greater depth of emotion than what can be seen on the surface. Finally, I discuss the reason why this longing exists in the first place and how it could quite possibly be a faulty human condition that still exists within the generations of our own time.

Undergraduate Student

Is King Richard a True Machiavellian? Comparing The Prince to The True Tragedy of Richard The Third

Primary Author: Christopher Fairchild, English

Advisor(s): Kristen Deiter

Richard III is one of the most infamous villains in historical drama. His actions and mannerisms are often categorized as Machiavellian. However, his portrayal in The True Tragedy of Richard The Third by an unknown playwright does not entirely fit the criteria for a Machiavellian villain. In addition, upon comparing this Richard III with Machiavelli's The Prince the definition of a Machiavellian villain does not align with what The Prince establishes. In this paper I analyze the definition of a Machiavel, how this play's portrayal and other portrayals of Richard III fits this definition, and other portrayals, how the modern interpretation of Machiavel is skewed by historical controversy. In doing so, I assert that this portrayal of Richard III is not a traditional Machiavellian, and that the definition of Machiavel does not follow what its namesake intended.

Undergraduate Student

The Never-Ending Chase: Unrequited Love in Shakespeare's Venus and Adonis and the Merchant of Venice

Primary Author: Trinity Howard, English

Advisor(s): Kristen Deiter

This essay analyzes William Shakespeare's employment of the Petrarchan theme of unrequited love in Venus and Adonis and The Merchant of Venice. While the theme presents itself most discernibly in Venus and Adonis, Antonio's absolute devotion to Bassanio in The Merchant of Venice confirms the existence of this paradigm exists in their friendship. Through Venus and Antonio, Shakespeare explores the demands, consequences, and disappointments of misplaced admiration. Venus willingly endures Adonis's rejections, and this accelerates her pursuit of him. Antonio incurs tremendous financial and physical debts to honor his love for Bassanio, while Bassanio allows Antonio to risk execution for him. Venus and Antonio's reactions to these situations cement the notion of unrequited love.

The Petrarchan theme of unrequited love highlights the effects of love not reciprocated, and I provide evidence of this theme in both Venus and Adonis and The Merchant of Venice. Shakespeare expounds upon unrequited love throughout both works through the actions of the lovers and the rejectors. I investigate the development and unfolding of each relationship and demonstrate the effects on Venus and Antonio. I wrote this paper for my Shakespeare course in spring 2021.

Department of Foreign Languages

Undergraduate Student

The Future of the Past; The Pandemic's Effect on German Museums

Primary Author: Sydney Edwards, Foreign Languages

Advisor(s): Dr. Sheehan

Germany's network of over 7,000 museums provides informative experiences and contributes significantly to the culture. However, during the COVID-19 pandemic, Germany's museums have had to develop new strategies to preserve their role. This project explores alternative methods that have been implemented and the effect on museum culture.

Undergraduate Student

Industries of Vice: Alcohol, Tobacco, and COVID in Germany

Primary Author: Daniel Frost, International Business and Cutltures

Advisor(s): Martin Sheehan

Alcohol and tobacco consumption, while unhealthy, are considered a major social aspect in German Culture. Due to Covid restricting social interactions, one might expect these vice industries to naturally see a significant drop in demand and profit; however, while other markets struggled, these industries' numbers steadily increased. This project will explore how alcohol and tobacco companies have reacted and why the increase in their numbers occurred during the recent global pandemic.

Undergraduate Student

Closing Time?: German Foodservice During a Pandemic

Primary Author: Patrick Howard, International Business and Cultures

Advisor(s): Martin Sheehan

The COVID-19 pandemic continues to present major financial challenges for the foodservice industry across the globe. This was especially the case in Germany, where increased restrictions have been placed on these businesses compared to other countries. This project explores how the German foodservice industry is adapting to the financial, health and safety, and operational challenges they are facing during the COVID-19 pandemic.

Undergraduate Student

Safe Sex?: The German Sex Industry and the Pandemic

Primary Author: Stephenie Martin, Foreign Languages

Advisor(s): Julia Gruber

Sex work is a legitimate profession in Germany, requiring work permits and identification from anyone hoping to pursue the profession. When searching for employment in the sex work industry, workers are just as, if not more, heavily regulated than other industries. Registered sex workers are required to carry valid government-issued registration, must use condoms and contraceptives when any sexual act is performed, and must submit to regular health checks. This structure and regulation should, in theory, protect sex workers and validate their profession; however, German sex work is still considered taboo, many suffering from social stigma. Sex workers are suffering

more than usual due to restrictions from Covid-19. Sex work is solely dependent upon human interaction. Given that Covid-19 is an airborne virus that is easily transmissible through droplets and close contact, the on-going pandemic has impacted the structure of the sex work industry significantly. This project will focus on the adverse effects Covid has had on the physical safety, mental health, and economic standing of sex workers in Germany.

Undergraduate Student

Economies and Ecologies: How German Forests Can Survive Climate Change

Primary Author: Nancy Rose Webb, Foreign Languages

Advisor(s): Martin Sheehan

Since Roman times, forests have played a significant role in German history, culture, and industry. The increasingly damaging impact of climate change has started to threaten German forests like never before. This project explores how (and why) contemporary organizations, municipalities, companies, and others are working to preserve Germany's iconic forests. Although the effects have been monitored for years, the current trajectory of devastation will soon lead to a tipping point if Germans do not unite and change.

Undergraduate Student

Renewed Interest in Renewables: Green Energy and Political Power in Germany

Primary Author: Conor Jones, International Business and Cultures

Advisor(s): Martin Sheehan

The next 20 years of the German energy industry is going to be among the toughest it will face. With the federal government bringing the renewable target date forward by 15 years to 2035, the question arises how will the Germans actually navigate the economical, logistical, and sustainability issues presented to them while still effectively supplying energy. Given the recently announced halt of the Nord Stream 2 pipeline and the drawdown of its nuclear power production, Germany might literally leave people in the cold if it does not manage to develop hydro, solar, and wind production effectively.

Department of History

Undergraduate Student

Connecting Bootlegging and NASCAR

Primary Author: Colton Davis, History

Advisor(s): Allen Driggers

From some of the first stock car races to the inception of NASCAR in 1949, automobile racing has been a prominent feature of the American South. Similarly, moonshiners and bootleggers also took prominence in the same region. While the old saying goes that NASCAR was inspired by bootleggers outrunning local sheriffs in their modified cars, the real history goes deeper. Other than Bill France's role in promoting NASCAR it was the moonshine kingpins that created the two main foundations of NASCAR, the race tracks and the drivers. Without the support of the moonshine and bootlegger industry, NASCAR and stock car racing would not have blossomed into the internationally recognized sport that it is in the twenty-first century.

Undergraduate Student

The European Question in America, 1861-1865

Primary Author: Summer King, History

Advisor(s): Allen Driggers

International relations have been a major aspect of almost all countries. Such was the case for the Confederate States of America as they needed foreign recognition to secure their hope of becoming their own country after breaking away from the United States of America. To achieve this, the Confederate government approached Great Britain in hopes of securing diplomatic relations, foreign recognition, and an ally in the American Civil War. On one hand, foreign relations with the Confederate States of America seemed positive due to Confederate cotton. However, the British government ultimately decided that it would be too costly for them to enter into such a position. Ultimately, Great Britain's recognition of the Confederate States of America would have sparked a nationwide famine from the loss of United States wheat, the decline of their international image due to them supporting a country that has institutionalized slavery, and the unrest of the British population due to there being an anti-war consensus after the Crimean War. Thus, the British government decided to keep their relations with the United States rather than formally recognizing or making treaties with the Confederate States of America.

Department of Mathematics

M.S.

An Introduction to Wavelets and Multiresolution Analyses with an Application to Digital Signal Processing

Primary Author: Sydney Clere, Mathematics M.S.

Advisor(s): Amy Chambers

In this project we explore properties of the Haar wavelet and how it is used in multiresolution analysis. Using insights gained from the Haar wavelet, we look at wavelets in a more general sense, deriving crucial properties. To investigate these properties, we often look through the lens of the Fourier transform. Due to the convolutional structure of many of our identities, taking the Fourier transform creates simpler multiplicative identities that we can prove. The multiresolution analysis of a function is determined by the wavelet used. We will investigate an example of decomposing a signal using its multiresolution analysis via the Haar wavelet. Other types of wavelets will be discussed briefly. Wavelets also give rise to wavelet transforms. This project will then cover some basic properties of wavelet transforms and an introduction to their applications in digital signal processing.

Department of Physics

Undergraduate Student

Designing a Laser Ablation Ion Source

Primary Author: Zachary Hinchman, Mechanical Engineering

Co-Author(s)/Collaborators: Jackson Dittert

Advisor(s): Mustafa Rajabali

A laser (ablation) ion source was designed for use in a university ion beam facility with an objective of generating a consistent output of ions in an ultra-high vacuum environment. To accomplish this, the apparatus uses motors similarly to a 3D printer to allow a Nd:YAG laser to evenly ablate the entire surface of a sample target multiple times. This mechanism has two motors on two different axes: one that rotates the target and one that moves it in the vertical direction. Vacuum-rated materials are used in the design, including acetal plastic, aluminum 6061, and stainless steel 316L. The challenges encountered in designing the ion source, which include the efficient use of the available space, incorporating repurposed parts from an old cesium sputter source, and the provision and isolation of high voltage to the appropriate parts of the ion source will be discussed in this work.

Undergraduate Student

Integral Method for Fitting Nuclear Decay Chains

Primary Author: Richard Mitchell, Physics

Co-Author(s)/Collaborators: Charlie Rasco, Oak Ridge National Lab

Advisor(s): Mustafa Rajabali

The conventional method for determining unknown half-lives of isotopes in data that have many decay chains is by fitting radioactive decay curves using the Bateman equations. The fit gets difficult in cases with very low statistics on the fast-decaying components. To compensate for the low statistics, we propose a new method for fitting and extracting these half-lives. The new method consists of making an integral histogram of all the counts recorded from the radioactive isotope, then fitting the histogram with an integral of the Bateman method. In this work we show results from the new algorithm which was used to test the integral method. The benefits and drawbacks of the integral method will be discussed as well as fitting results from use of the integral method.

Undergraduate Student

Light Attenuation in Scintillators

Primary Author: Emma Mitchell, Physics

Advisor(s): Mustafa Rajabali

Light attenuation is the dimming or diminishing of light intensity as it passes through a medium. Through the utilization of analog and digital data acquisition systems, we began to set up an experiment to study light attenuation in scintillators with the purpose studying the efficiency of light detection in a scintillator over a two-year period. By reviewing different software and comparing methods of processing and collecting the signal passed through the EJ 276 inorganic plastic scintillation bar, we began to develop a method and setup for data collection. Despite many difficulties with the hardware and software, we determined the relevant components to process the signal and analyze the output data and eventually came to a final version of an experimental set-up.

Undergraduate Student

A Survey of 3D Printed Materials for Vacuum

Primary Author: Imran Mohammed, Computer Science

Advisor(s): Mustafa Rajabali

When working with vacuums, objects placed in the chamber must be vacuum grade or manufactured to be able to withstand and maintain your vacuum. This can be costly or may take a long time for the part to be manufactured. 3D printing, on the other hand, has become more prominent in many professions as a quick and cheap way for making components you need. The purpose of this research is to determine how different 3D printed materials behave in vacuum, in hopes to find a certain material that will allow researchers to 3D print any object they may need. The research consists of using a Pfeiffer HiCube vacuum pump along with 3 pressure gauges: a Wasp, a Hornet, and a Convectron. Each gauge is connected to an Arduino that will measure the pressure inside the chamber over time with a python script to plot and fit the data for analysis. Different 3D printing materials such as PLA, ABS, and Nylon were quantitively compared. The research thus far has consisted of getting each of these tools ready to begin the data collection. With these tools we will be able to document the rate of outgassing for each material and make suggestion on the best material to use for 3D printed vacuum components.

Department of Sociology and Political Science

Undergraduate Student

Black Injustices in the Criminal Justice System (Video Project) (VIDEO PROJECT)

Primary Author: Deshun Coonrod, Sociology

Advisor(s): Ada Haynes

African Americans have been targeted, killed, and judged unruly in the United States by the police more often than white individuals (LaFraniere and Lehren, 2021). Thus, the problem is that the latest struggle for black lives is for society to recognize the humanity of African Americans and enable them to live freely, safely, and equally (Marilyn, 2021). Racist police behavior today is part of a deep legacy of racism in the United States, which often finds its extreme manifestations in law enforcement (Gabiner,2016). Black youth are 41% more likely to be victims of any police use of force than comparable White youth. Sadly, the patterns are similar when we predict stops in which officers pull their guns and are prepared to shoot. Black youth are over 50% more likely in similar stops to find themselves staring down the barrel of a gun than white youth (Rory, 2017).

The discriminatory consequences of the war on drugs are clear. Three-quarters of those arrested for drug offenses are Black or Latino. In seven states, 80 to 90 percent of incarcerated drug offenders are Black. These differences cannot be explained by disproportionate drug use among African Americans; studies show they don't use drugs more than any other group, and some studies have even found they use drugs less often than other groups (Butler, 2010). My main priority is to find ways to let African Americans be heard and to make it safer for them to live their lives.

College of Education

Department of Counseling and Psychology

M.A.

Career Decision-Making in College Students: A Path Analysis of Early Childhood Attachment, Gender, Age, and Socioeconomic Status

Primary Author: Lara Strate, Counseling and Psychology M.A.

Advisor(s): Tony Michael

Career decision-making and identifying the associated variables that influence career development has been an area of considerable interest throughout vocational and occupational literature. The purpose of this study was to explore the effect of gender, age, socioeconomic status, and early childhood parental attachment on career decision-making. Participants included 309 college students who completed a demographic questionnaire, the Adult Scale of Parental Attachment-Short Form (ASPA-SF), and My Vocational Situation (MVS). Responses were examined through structural equation modeling using a path analysis in AMOS. Results indicated an overall acceptable model fit and the specific strength the corresponding variables had on career decision-making. Implications and areas for future research are proposed.

Ph.D.

Warrior Mentality and the Related Impact on Law Enforcement Officers' Perceptions of Mental Health through the Lens of Critical Race Theory

Primary Author: Amanda Nowlin, Counseling and Supervision Ph.D.

Advisor(s): Tony Michael

The purpose of this presentation is to highlight the concept of warrior mentality in law enforcement culture and the related implications on Law Enforcement Officers' (LEO's) mental health. Drawing upon critical race theory and a methodological review of the literature, the objectives will be to 1) define warrior mentality in the law enforcement setting, 2) describe warrior mentality and its relationship in critical race theory, 3) distinguish best practices for providing mental health services to this population, 4) discuss alternative treatment methods that could serve this population more effectively, and 5) promote an understanding of warrior mentality with an emphasis towards advocacy for LEO's mental well-being. Limitations and areas for future research will also be presented.

Ph.D.

The Professional Role and Training of Counselors for Natural Disaster Response

Primary Author: Dessie Avila, Counseling and Supervision Ph.D.

Co-Author(s)/Collaborators: Mason Hale; Amanda Nowlin

Advisor(s): Tony Michael

This poster presentation aims to underline the role of counselors in response to natural disasters and propose developmental pathways for counselors in disaster response preparedness. Researchers have suggested a greater comprehensive intervention model is warranted for natural disaster response (Holder et al., 2017). Therefore, a conceptual counselor competence response model

will be introduced. As natural disasters may impact the mental health wellness of survivors, this presentation also seeks to expound the importance of the dissemination of knowledge regarding available mental health resources within Tennessee and extend a discussion for organizing a community structure that connects natural disaster victims with qualified mental health professionals.

Ph.D.

Comparing Parental Attachment Development and Attachment to God

Primary Author: Mason Hale, Counseling and Supervision Ph.D.

Co-Author(s)/Collaborators: Amanda L. Nowlin; Dessie S. Avila; Scott Herman; Tony Michael, Tennesseee Technological University - Department of Counseling and Psychology

Advisor(s): Tony Michael

This presentation aims to highlight the relationship between parental attachment styles and types of attachment to God. Counselors are trained to focus on holistic mental wellness, and attachment theory is one approach to the therapeutic process (Bock et al., 2021). Patterns of relating to others are constructed from one's early childhood experiences (Ainsworth, 1985; Granqvist & Kirkpatrick, 2008; Griffen & Bartholomew, 1994)) which can be observed through the individuals' style of attachment to God (Belavich &. Pargament, 2002). Maladaptive responses to adverse experiences affect the development of these patterns in relation to parents, others, and even potentially God (Kirkpatrick & Shaver, 1992). One paradigm that has been utilized in therapeutic practice and research is the Correspondence and Compensations models (Granqvist, 2002; Hall et al., 2009). This presentation will review these models, previous research findings, and extend a discussion based on this theoretical model.

Ph.D.

Exploring the TAS-20

Primary Author: Stephanie Karlosky, Counseling and Supervision Ph.D.

Advisor(s): Tony Michael

The Toronto Alexithymia Scale-Revised (TAS-20) is a frequently used questionnaire designed to evaluate the construct of alexithymia. The TAS-20 employs a three-factor model which includes difficulty identifying feeling (DIF), difficulty describing feeling (DDF), and externally oriented thinking (EOT). The purpose of this study is to compare and contrast the application of alternative factor models of the TAS-20 with the original three-factor. A confirmatory factor analysis was completed on a sample of college students enrolled in undergraduate psychology courses at a university located in the southeastern United States (n= 357; 63.1% male, age 18-57 years; M=19.40). Results from the CFA analysis and tests of dimensionality supported the original three-factor model (GFI .901; CFI .907; RMSEA, .058) as the best model fit. Concerns of convergent validity were noted within the subscale AVE analyses (DDF, 0.428; DIF, 0.500; and EOT, 0.141). Further analysis of the EOT scale revealed concerns regarding discriminant validity (AVE, 0.141; MSV, 0.134). Factor loadings were replicated for fifteen of the original items. This study's findings conclude the usage of the TAS-20 provides greater understanding of alexithymia and its constructs (subscales). The use of the TAS-20, specifically the consideration of the subscale scores, within clinical settings may provide clinicians with greater insight working with clients.

Ph.D.

An Investigation of the Factor Structure and Psychometric Properties of the Adverse Childhood Experiences Scale in College Students

Primary Author: Brittney Phillips, Counseling and Supervision Ph.D.

Advisor(s): Tony Michael

The purpose of this study was to examine the psychometric properties of the Adverse Childhood Experiences scale through exploratory and confirmatory factor analyses with a sample of college students (N=354). Health care professionals are being encouraged by the CDC to utilize the ACEs inventory to assess for negative events in childhood as the results are associated with physical and mental health concerns later in life. A 1-factor scale that sums an overall total score is commonly employed. Utilizing SPSS and AMOS software, the researchers compared a 1-, 2-, and 3-factor structure of the scale as theorized in a literature review. The results indicated a 3-factor model of abuse, neglect, and household dysfunction had the best overall model fit indices. A discussion on the conceptual transition from a 1-factor to a 3-factor scale and accompanying implications about scoring and interpretation is provided. Limitations and areas for future research are also expounded.

Undergraduate Student

The Effect of Angry and Sad Facial Expressions on the Perception of Warmth and Competence: Interactions with Gender and Race

Primary Author: Rachel Day, Psychology

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

Co-Author(s)/Collaborators: Nicole Henniger

Advisor(s): Nicole Henniger

This study tested whether counter-stereotypical emotional expressions (males expressing sadness and females expressing anger) were rated differently on warmth and competence. A three-way interaction among race, gender, and emotion suggested that gendered expectations about emotion expression depended on race; this interaction was replicated in a second study with different stimuli.

Undergraduate Student

Examining the Relationship Between Identity and Shame Resilience

Primary Author: Livia James, Psychology

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

Advisor(s): Nicole Henniger

In recent decades, shame resilience has been implicated as an important factor of mental health. However, it is unclear what factors predict resilience when feeling shame. Identity could be a key factor. Shame is a social emotion, and one's sense of collective versus individual identity could influence how one deals with the experience of this emotion. This study investigated the potential relationship between one's identity orientation and level of shame resilience. If one's identity orientation is related to shame resilience, this could have implications for helping people cope with feeling shame and providing support for mental health.

This correlational study gave established self-report scales measuring identity orientation and shame resilience to ~150 college students in the United States. We predicted that those who scored high in the collective and the relational identity categories would score higher in shame resilience than those who scored low in these areas and that those who scored high in the personal and social identity orientations would have lower shame resilience scores than those who scored low in these areas.

Undergraduate Student

The Influence of COVID-19 on Impostor Syndrome

Primary Author: Courtney Richardson, Psychology

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

Co-Author(s)/Collaborators: Mattthew Zagumny, Tennessee Tech University

Advisor(s): Matthew Zagumny

Impostor Syndrome (IS) can be described as an intense feeling that one's accomplishments are unjustified and that he or she does not deserve recognition for them. These feelings are accompanied by a fear that they will be exposed as a fraud among their colleagues. IS has been shown to be a serious detriment to overall mental health. Previous research has suggested that people with IS feel incessant insecurity and often overwork themselves to offset their supposed weaknesses.

COVID-19 has altered the lives of all people. With this, students have been introduced to numerous new stressors including classes shifting from in-person to remote instruction. Research has shown that online classes are linked with higher rates of learning loss, leaving students feeling unprepared to advance in their careers. This study will evaluate individual COVID-19 impact (finances, education, mental health, etc.) in comparison to symptoms of IS in college students through an online survey. We expect that students that have been highly impacted by COVID-19 will present higher levels of IS symptoms. This study will assess the sources of IS and present significant implications on the impact of COVID-19.

Department of Curriculum and Instruction

Ph.D.

The Relationship of Adverse Childhood Experiences, Protective and Compensatory Experiences and Children's Flourishing

Primary Author: Adrianne Colquitt, Exceptional Learning Ph.D.

Advisor(s): George Chitiyo

While the widespread negative impacts of Adverse Childhood Experiences (ACEs) are well researched, information regarding Protective and Compensatory Experiences (PACEs), their relationship to ACEs, and children's ability to flourish is less understood. The specific categories of adversity examined in this study include: hard to financially cover basics; parents separated or divorced; parent died; parent served time in jail; witnessed or experienced physical abuse; lived with anyone who was mentally ill; exposure to substance abuse; and treated or judged unfairly due to race/ethnicity. The categories of protective experiences examined in this study include unconditional love; having a best friend; volunteering; being a part of a group; having a mentor; living in a clean, safe home with enough food; getting an education; having a hobby; regular physical activity; and having rules and routines. Utilizing the 2019 National Survey of Children's Health data, this study explores the relationship between ACEs, PACEs and children's ability to flourish. This study also investigates the theory that PACEs could buffer the negative impacts of adversity by moderating the relationship between ACEs and children's ability to flourish. A better understanding of the relationship between ACEs, PACEs, and flourishing could lead to development of PACEs-related programming and further research regarding how communities can help children build resilience and potentially lessen the impacts of ACEs.

Ph.D.

Effects of Social, Professional, and Spiritual Support on Anger and Irritability Among Physical Abuse Survivors

Primary Author: Marlana Lastres, Exceptional Learning Ph.D.

Advisor(s): George Chitiyo

Childhood abuse is a rampant concern throughout the nation. After reviewing the literature, a potential gap and opportunity to examine and better understand the trauma symptom of anger and irritability among childhood physical abuse survivors revealed itself. The purpose of this research was to examine the relationship between social support coping mechanisms, professional support coping mechanisms, and spiritual support coping mechanisms and anger and irritability among survivors of childhood physical abuse controlling for sex and race. The research study utilized a descriptive correlational design using multiple regression to analyze data from the National Data Archive on Child Abuse and Neglect (NDACAN) dataset 170 titled Longitudinal Studies of Child Abuse and Neglect (LONGSCAN) Assessments 0-18 (Runyan et al., 2014). These data have been collected from survivors, their caregivers, and educators in the Southwest, East, and Northwest regions of the United States between 1991 and 2012. Findings suggest that some coping mechanisms do have a predictive effect on anger and irritability scores of physically abused adolescents. Identifying and understanding these coping mechanisms can inform future supports developed to aid adolescent survivors of physical abuse struggling with anger and irritability.

Ph.D.

Preservice Mathematics Teachers' Perspectives of Mathematics Tasks during a Mathematical Letter Writing Exchange

Primary Author: Carey Wilson, Exceptional Learning Ph.D.

Advisor(s): Holly Anthony

The author interviewed participants individually and conducted a focus group interview with three preservice mathematics teachers (PSMTs) attending a southern university in this interpretive case study. The author also gathered the PSMTs' final reflection papers related to a mathematical letter writing exchange (MLWE) in which they participated. The research questions were: What were the PSMTs' perceptions of value after participating in a MLWE with high school students? How did PSMTs' thinking about the qualities of a good mathematical task evolve as they participated in a MLWE? For this study, the author used open coding and inductively analyzed the interviews. In comparison, directed content analysis guided analysis of the papers, letters, and mathematical tasks to determine the PSMTs' perceived value of the MLWE experience. PSMTs should form strong relationships with students to help build students' confidence in doing mathematics. Also, explicit and implicit structures existed in the descriptions of a good mathematical task. For example, the participants reported they needed to find or create mathematical tasks that matched their penpals' interests. Additionally, one intrinsic theme indicated that preservice teachers should consistently prioritize mathematics in their feedback and discussions with students. Finally, the findings built off of prior literature surrounding MLWEs. This will help future PSMTs become more successful in their future teaching practices.

Ph.D.

Risk Factors, Instrumental Motivation, and Students' Fulfillment of Academic Expectations: A Moderation Analysis

Primary Author: Kinsey Simone, Exceptional Learning Ph.D.

Co-Author(s)/Collaborators: George Chitiyo

Advisor(s): George Chitiyo

While many students have high school expectations to attain a postsecondary degree, certain factors lead to discrepancies in whether they do or do not attain those expectations. This moderation analysis examined the extent to which parents' expectations, when interacting with students' number of academic risk factors and instrumental motivation, predict fulfillment of expectations. Data from the 2002 Educational Longitudinal Study were analyzed using AM Software, controlling for race and gender. Although parents' expectations were a significant predictor of expectation fulfillment, they did not account for significant variance in the outcome variable. The interaction between instrumental motivation and parents' expectations was not a significant predictor of expectation fulfillment. However, the interaction between parents' expectations and academic risk factors was a significant predictor of expectation fulfillment. Implications for future research include examining how specific risk factors and parents' expectations are correlated.

Department of Exercise Science

Undergraduate Student

Is There a Relationship between Lower Body Power and Speed?

Primary Author: Noah Schwartz, Exercise Science

Co-Author(s)/Collaborators: Nicholas Haynes

Advisor(s): Michael Phillips

The purpose of this study was to determine if there was a relationship between a person's lower body power and speed. Fifteen Exercise Science students (8 male and 7 female) participated in the study with ages ranging from 20 to 41 (23 ± 1.2 years). The instruments used in this study were the Brower Timing System (for run times) and the Just Jump Mat (for vertical jump measurements). All participants performed high knees, butt kicks, lunges, and a light jog for a warm-up. Participants were then asked to perform two timed 40-yd dash runs (5.75 ± 0.71 s) with their fastest time being recorded. Following the timed runs, participants performed two vertical jumps (18.88 ± 5.04in) with their highest jump being recorded. A Pearson correlation coefficient was computed to assess the linear relationship between lower body power and speed. There was a negative correlation between the two variables, $r(13) = -.75$, $p = < .05$. The results also showed that lower body power was a good predictor of speed, but was found to not be the only underlying factor in an individual's top speed. Furthermore, lower body power could help an individual in achieving their top speed, but is not a factor in maintaining top speed. This topic could benefit from more research into other factors in an individual's top speed.

College of Engineering

Department of Chemical Engineering

M.S.

An Asymptotic Solution Approach to Dialyzer Design

Primary Author: Mckellan Gonzales, Chemical Engineering M.S.

Advisor(s): Pedro Arce

Chronic Kidney Disease affects 1 in 7 adults in the U.S. Of the affected population 2 in 1000 Americans are living with end stage kidney disease that is treated with either a kidney transplant or dialysis. Of the affected population, on average, patients 66 and older will spend $23,000 on medical treatment and have a mortality rate almost twice that of the population without chronic kidney disease. This has led to a need for increasingly more efficient and compact dialyzers. Out of all possible geometries for dialyzer design, the geometry of a multi-capillary shell and tube design has been most prominent in commercial use. However, the current design standards for dialyzer design need further refinement in order to increase their efficiency and therefore reduce their size to the smallest possible commercial device. In this research we derive an asymptotic solution for a dialyzer with contaminants and assess the feasibility of the solution. Moreover, and based on the asymptotic solution, a preliminary design criterion for the dialyzer design will be presented. Justification for the asymptotic solution and its feasibility region will be shown as well as the future work to generalize the presented research.

M.S.

Direct Formic Acid Fuel Cells: Mass Transport Optimization of the Anode Catalyst Layer

Primary Author: Steven Lam, Chemical Engineering M.S.

Advisor(s): Cynthia Rice

To meet the ever-rising demand for portable power sources, batteries have become a vital part in mobile electronics such as cell phones and laptops. However, the efficiency of batteries is compromised due to exponential degradation over time, lengthy recharging times, and limited charge capacity. Direct formic acid fuel cells (DFAFC) present an alternative to batteries, due to their near instantaneous re-fueling times, higher efficiency, and 24/7 operation capabilities. However, two-phase flow in conjunction with the small pore size between anode catalyst agglomerates (~20 nm) restricts the cellâ€™s efficiency. To improve the mass transport gaseous products (carbon dioxide) and liquid reactants (formic acid), a pore-former is integrated into the anode catalyst layer during fabrication and subsequently removed. The additional templated porosity enhances the two-phase mass transport in and out of the anode catalyst layer.

Previous work has been done with the addition of a smaller pore-former, MgO (~50 nm) resulting in an increase in cell performance and electrochemical surface area. [2] The intent of the pore-former is to increase the porosity of the anode catalyst layer while retaining the connectivity of the agglomerates. The present work aims study more variations in the wt% of pore-former (0-60 wt%).

1. Lam, S., Bixby, M.M., and Rice, C.A., Optimization of Mass Transport within Direct Formic Acid Fuel Cell Catalyst Layer via Pore Formers. 2020, 98, 355.

M.S.

Molecular Dynamics Investigation on Branched Alkane-Air/Water Interfaces

Primary Author: Praveen Pilyanam, Chemical Engineering M.S.

Advisor(s): Liqun Zhang

Alkanes are important raw materials of the chemical industry and are the major contribution of crude oil. They also have a lot of applications in water flooding and surfactant flooding, thus working on the interfaces between alkane with water/oil is important. NAMD simulations have been used to examine the properties of branched alkanes in air and water interface systems. A total of eight branched alkanes (2-methyl octane, 2,4-dimethyl nonane, 2,6-dimethyl nonane, 2,7-dimethyl nonane, 2,7-dimethyl decane, 2-methyl undecane, 3-methyl undecane and 5-methyl undecane) have been focused at four different temperatures (300K, 358K, 400K, 443K). CHARMM forcefield was applied and periodic boundary conditions were defined. The surface tension, diffusion coefficient and radial distribution functions of alkanes in bulk and in the interface were calculated. To determine the surface tension correctly, the density profiles were also calculated and compared with the available experimental data. As the temperature increases, surface tension and density decrease while diffusion coefficient increases. At temperatures greater than the boiling points of alkanes, the density profile shows uneven behavior. The simulated data with this model are found to be consistent with the available experimental data.

Ph.D.

Modelling of Fluid Flow and Mass Transfer in a Fiber Reactor using Computational Fluid Dynamics

Primary Author: Oluwaseyi Ayeni, Engineering Ph.D.

Co-Author(s)/Collaborators: Ahmad Vaselbehagh, Tennessee Technological University/Fluid Mechanics Research Laboratory

Advisor(s): Holly Stretz

Flow visualization experiments in micro channels output information on the fluid flowrates, heat transfer coefficients, mass transfer coefficients, size and stability of droplets etc. These data are useful for designing microfluidic processes, scaling up, fine tuning process parameters and, optimization. Some cons in conducting experimental observations are the time it takes to design and set-up Also, several experiments are conducted varying so many parameters. The research is focused on modelling and simulating parallel multiple microfluidic channels using Computational Fluid Dynamics techniques. These channels are comprised of thousands of micron-sized steel fibers that bring into contact two immiscible phase with enhanced mixing and separation capabilities. Fluid flow has been modelled using the COMSOL software and the droplet break-up was observed in these channels. The velocity, pressure and fluid-fluid interphase plots are presented. Due to large difference in the scales of features in the reactor, the models had to be solved using high performance computing. The simplification of the model by the application of symmetry and periodic boundary conditions was explored. The results of these modifications are also reported and compared with the former method. Results from parametric studies on relative velocity, temperature, relative viscosity and contact angle are presented.

Ph.D.

Role of Nanocellulose Hydrogels in Regenerative Medicine: Preliminary Observations

Primary Author: Anfal Haris, Engineering Ph.D.

Co-Author(s)/Collaborators: Pedro Arce

Advisor(s): Robby Sanders

Hydrogels in regenerative medicine applications is a growing field. The similarities of the material characteristic and properties e.g., permeability, biocompatibility, and high-water content of hydrogels and the structure of a natural tissue make them attractive materials to mimic the environment of extra cellular matrix (ECM). Therefore, they are plying an increasing role in tissue engineering, cellular therapy, microfluidic devices, and 3D bioprinting. Furthermore, hydrogels allow scientists to study disease outside the body by developing cellular representative systems for human diseases, drug testing. Incorporating nanomaterials as “fillers” into hydrogels to obtain nanocomposite hydrogel scaffolds seems encouraging as an individual material might lack or have limited characteristics to a certain functionality. Cellulose nanocrystals (CNCs) based hydrogels are very promising materials as scaffolds for many regenerative medicine applications, due to their biocompatibility, renewable raw material nature, and hydrophilicity. The goal of this study is to synthesize CNC-polyacrylamide gels containing varying concentrations of CNCs and investigate the influence of CNCs on the microstructural and rheological properties of polyacrylamide nanocomposite gels. Thus, CNC-polyacrylamide gels will be considered in this study as a potential material for tissue engineering applications. Details about preparation and characterization of these nanocomposite hydrogels will be discussed.

Ph.D.

Mechanically Robust Egyptian Blue Coated “Super Marbles”

Primary Author: Agoston Kiss, Engineering Ph.D.

Advisor(s): Holly Stretz

A liquid marble (LM) is a small volume of liquid (water or glycerol) encapsulated by hydrophobic particles self-organized on the vapor-liquid interface. LMs are an emerging platform for sensing applications in various fields and could be potential sensor candidates in water treatment. An ancient pigment, Egyptian Blue (EB, cuprorivaite), has also received increasing attention in sensing applications recently due to its high quantum yield (F = 10.5%), long luminescence lifetime (107 Âµs), and intense near-infrared emission at 910 nm. To enable EB in sensing applications, a uniform coating of EB nano- or microparticles must be engineered. The uniformity of the coating will ensure the performance of the sensor’s coating. LMs are a great tool to engineer uniform coatings of nano- or microparticles, however they break very easily under pressure, which severely limits their use in everyday applications. One possible way to overcome the breakage issue of LMs could be to introduce a more durable core. EB was exfoliated and then surface modified with trichlorovinylsilane to become hydrophobic. A drop of POLYCRYLIC topcoat or Gorilla Epoxy Glue was placed into the hydrophobic Egyptian Blue powder and rolled around to engineer a uniform coating around the marble. The marbles were allowed to harden overnight. Here we report the reaction conditions and synthesis of such liquid marbles aimed at sensing applications, as well as its fluorescent emission in the infrared region.

Ph.D.

Modeling the Time-Dependent Rheological Behavior of Cement Paste

Primary Author: Babajide Onanuga, Engineering Ph.D.

Co-Author(s)/Collaborators: Joseph Biernacki

Advisor(s): Joseph Biernacki

The ability to control and predict the rheological evolution of cement paste is crucial to achieving structurally sound materials in large-scale 3D printing applications. The rheology of cement paste depends on several physical and chemical properties of the cement and the paste formed thereof. Also, the way that the paste was processed matters, including how it was mixed and even the measuring conditions. Furthermore, cement pastes display flow curves wherein shear stress is a function of how long the paste has been sheared, and thus exhibits time-dependent rheological behavior. Such suspensions exhibit a transition from thixotropic to anti-thixotropic flow. As a result, it is difficult to identify and characterize intrinsic rheological properties without a suitable model that captures most of these characteristics.

In this work, a two-part constitutive model has been developed to explain the time-dependent rheological behavior of cement suspensions. Carefully designed rheometric experiments including repetitive cyclical ramp up and ramp down flow protocols were performed on cement pastes to obtain rheology data. The two-part model adequately captures the related time-dependencies, thixotropy and anti-thixotropy, the transitions between the two, and more importantly structure state reversibility upon resting the paste, a condition that must be satisfied. Parameters of the model were estimated, and physical explanations provided in the context of printing applications.

Ph.D.

Emerging Biopharmaceuticals in Wastewater: A Classification of Treatment Approaches Based on Photo, Electro and Electro-Photo Catalytic Methods

Primary Author: Dipendra Wagale, Engineering Ph.D.

Co-Author(s)/Collaborators: Claire Myers; Robby Sanders

Advisor(s): Pedro Arce

There is an emerging family of biopharmaceutical contaminants present in wastewater that includes a sizeable number of molecules originated in the partial metabolism of medicines used for both animal and human treatment. These contaminants represent a health hazard that need to be addressed. For this purpose, Advanced Oxidation Processes (AOPs) are suitable techniques in which highly oxidizing hydroxyl free radicals are generated by chemical or photochemical or electrochemical or photoelectrochemical methods that can indiscriminately attack and degrade them oxidatively into safer and simpler mineralized products such as water, carbon dioxide, and inorganic ions. Effectiveness and efficiencies of degradation depend upon the type of AOPs by which OH is generated, operating conditions, and the chemical and physical properties of the contaminants. In this study, we review the general approaches of AOPs with a focused study on heterogeneous photocatalytic methods that are applicable for removing various classes of emerging biopharmaceuticals that are growing rapidly in modern-day-wastewaters. We present a classification of the AOPs based on the mechanistic pathways by which OH radicals are generated. In addition to highlighting the removal effectiveness and degradation mechanisms of biopharmaceuticals by titanium dioxide based photocatalytic methods, a summary of early trends and recent advances in the advanced oxidation of biopharmaceuticals in wastewater is presented.

Ph.D.

The Electrical Potential in an Irregular Rectangular Domain: An Area-Averaging Approach

Primary Author: Abayomi Adeleke, Engineering Ph.D.

Co-Author(s)/Collaborators: Steffano Oyanader

Advisor(s): Pedro Arce

Electrostatic potentials are critically important for applications such as electrophoretic separation, microfluidics, and other electrokinetic-driven technology. As in other transport processes, the microscopic electrostatic equation and its boundary conditions depend upon the geometry of the domain, i.e. pore or capillary of the, for example, hydrogel used in this application. Since these materials display a complicated morphology of the pore network, "irregular domains" play an important role in capturing a realistic description of the electrostatic potential. Studies have shown that generally, diverging channels, a form of irregular channel, give better separation resolutions compared to regular channels. In this project, an area-averaging approach coupled with its closure condition are used for the analysis of the electrostatic potential in a diverging channel of rectangular geometry. Both area-averaged values of the electrostatic potential and its deviation are systematically determined and used to obtain the solution, i.e., the "local" or microscopic value of the potential without using other more mathematically involved techniques such as separation of variables. The presentation will discuss details about the up scaling of the microscopic electrostatic equation to the entire domain of the pore and some of its limitations as well as useful information such as the significance of the entrance effect.

Undergraduate Student

Understanding the Effect of Hydration on the Time-Dependent Rheological Behavior of Cement Paste

Primary Author: Elijah Allgood, Chemical Engineering

Co-Author(s)/Collaborators: Aniket Nandha; Babajide Onanuga; Joseph Biernacki, Laboratory for Alternative Materials and Energy

Advisor(s): Joseph Biernacki

This work investigates the effect of hydration on the overall evolution of the time-dependent rheological behaviors in cement paste at early ages. This was approached by studying the effect of shear history on the rheology of a hydration-active and hydration-dead Type I-II hydraulic portland cement paste, using cyclical flow curve measurements. The hypothesis is that if hydration is stalled, e.g., by using sugar, an aggressive hydration inhibitor, the effect of particulate only-driven rheological behavior can be studied independent of hydration. The flow rheology of cement pastes prepared in deionized water with and without the addition of sugar was observed. Sugar at 1% cement mass ratio shuts down hydration for several days. Comparative results show that a thixotropic to anti-thixotropic transition occurs for both hydration-active and hydration-dead cement paste suggesting that particle-association or flocculation de-flocculation-related structural changes dominant in early age cement pastes and are responsible for these flow state transitions.

Undergraduate Student

Free Energy Calculation on Human Beta Defensin Translocation through Bacterial Lipid Membranes

Primary Author: Ann Brewer, Biology

Advisor(s): Liqun Zhang

Human beta defensins (hBD) are cationic peptides, which assume small ÃŸ-sheet structures varying in length from 33 to 47 amino acid residues and are primarily expressed by epithelial cells. They belong to the human innate immune system and have a broad-spectrum of antibacterial activities. Despite structural similarities, hBDs have diverse antibacterial activities. A comparative study on hBD type 1 (hBD-1) and hBD type 3 (hBD type 3) is conducted, focusing on the translocation free energy prediction of hBDs through both model Gram-positive and Gram-negative bacterial membranes. GROMACS coarse-grained molecular dynamics simulations using Martini forcefields were performed on both hBD-1 and hBD-3 crossing both model Gram-positive and Gram-negative bacterial membranes to obtain accurate free energy barriers. To consider the concentration effect, hBDs in both monomer and dimer forms were studied. It was found that hBD-3 needs to overcome a lower energy barrier crossing Gram-positive bacterial membrane than Gram-negative bacterial membrane, and the higher the concentration, the lower the energy barrier. However, hBD-1 needs to overcome a lower energy barrier crossing the Gram-negative bacterial membrane than through Gram-positive bacterial membrane and is concentration independent. The simulation result can agree with experimental findings on the antimicrobial potent of hBDs and can help to explain the different antimicrobial activities of two different hBDs.

Undergraduate Student

Synthesis of Near-Infrared Pigments for Novel Sensor Applications

Primary Author: John Clark, Chemical Engineering

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

Advisor(s): Holly Stretz

Calcium copper silicate, known as Egyptian Blue (EB), is a pigment that exhibits a strong near-IR fluorescent emission when exposed to a strong light source. This property makes it a novel candidate for use as a basis for dissolved ion sensors, as its IR signal is very strong in comparison with current commonly used IR reporters, such as gold shell nanoparticles. Most commercially available samples; however, are created with dyeing and pigmentation in mind, rather than chemical application. To apply EB as a sensor lens component, it must be synthesized to form a reproducible and laboratory grade sample, free from compounds present in dyes that can affect the adherence and emission of an EB coating on a lens. In order to synthesize a sample of EB, a solid-state reaction was employed to react powdered crystalline solids under a high temperature environment. The resulting sample is then characterized through x-ray diffraction to determine the success of the solid-state synthesis.

Undergraduate Student

Electrotherapeutic Assisted Wound Healing: Comparison of the Electrostatic Potential in Porous Gel or Healing Media in Cartesian and Cylindrical Geometries

Primary Author: Phoebe Dawson, Chemical Engineering

Co-Author(s)/Collaborators: Steffano Oyanader; Robby Sanders; Pedro Arce, Tennessee Tech University; Robby Sanders, Tennessee Tech University; Mario A. Oyanader, California Baptist University

Advisor(s): Pedro Arce

Understanding the formulation and the modeling of distinct approaches used in the bio-mathematical foundation to homeostatic wound healing modeling is a

critical task to advance the field. In recent contributions (Jorgensen, 2017), researchers have made progress experimentally in understanding transport of biomedicines in hydrogels of potential use as an effective scaffolding material to facilitate wound healing. This effort has been complemented by modelling approaches (Dawson et. al., 2021) to increase the understanding of the electro-convective diffuse transport of biomolecules in wound healing in electrotherapeutic assisted wound healing applications. This contribution will focus on the methodology for modeling of the electrostatic potential effects in the wound microenvironment of the scaffolding material and the role that the chosen geometry plays on the electrostatic potential behavior. Specifically, the impact of the diffusion and the migration of thrombin to induce the conversion of fibrinogen to fibrin will be discussed in the rectangular and cylindrical geometry. Anchored by the RF Model to guide our efforts, elements of the EKHD will be used to formulate the microscopic scale models that, then, by following an area-averaging algorithm approach will be upscaled to the entire capillary domain. The solutions will be compared analytically and graphically through a set of parametric values. Future and ongoing efforts towards this project will be highlighted.

Undergraduate Student

Role of Intermediaries in the Degradation of Acetaminophen by Photocatalytic Methods: Preliminary Observations

Primary Author: Luke Horne, Chemical Engineering

Co-Author(s)/Collaborators: Sabrina Hurlock Buer; Dipendra Wagle; Robby Sanders

Advisor(s): Pedro Arce

Acetaminophen is one of the most common drugs used to treat minor pains and illnesses as well as to control fever. Due to both the widespread use of acetaminophen and its incomplete metabolism by humans, undesirable quantities of the drug may end up in our water systems even after partial microbial metabolic processes reduce the amount present in wastewater. This represents a significant health hazard as there are currently no treatment processes that are readily available for wastewater treatment facilities to remove acetaminophen from the water in its entirety. This project is seeking to test the feasibility of photocatalytic degradation of acetaminophen using photocatalytic methods via the immobilization of titanium dioxide on thin films. The overall goal of the project is to find the most efficient and effective experimental conditions for the of degradation of acetaminophen. One important aspect of this effort is to identify the role played by potential intermediaries due to the degradation of the drug and their possible interference in the efficiency of the process. After presenting experimental evidence of the presence of intermediate products, a theoretical analysis based on information found in the literature and molecular structures will be presented. Properties of the intermediary molecules as well as their contamination strength and future work needed to completely elucidate the role of the intermediaries in the process will be presented.

Undergraduate Student

The Effects Micromixer Design on Fibrin Diameter and Density

Primary Author: Spencer Legins, Chemical Engineering

Advisor(s): Robby Sanders

Hemostasis (which involves clotting) is the first stage of the dermal wound healing process. During this stage, fibrinogen and thrombin react yielding a dense fibrous structure known as a fibrin gel that aids in the clotting process; the way these reagents interact is posited to affect the fibrin gel structure. The role of micromixing

to expectedly alter these interactions is being explored. Specifically, four different models (Straight, Zigzag, 3D-Serpentine, and Helical) designed with varying levels of complexity including the use of perpendicular junctions and changes in centrifugal forces are being tested through simulations in COMSOLÂ®. These simulations will be supported by conducting experiments in which fibrin gels will be formed, critical point dried, and examined for structure. Between the four micromixers tested, it is expected that the simulations will show that as the complexity of the microfluidic mixer increases, the mixing efficiency will likewise be affected and structure changed. Using this information, new technologies and innovations could be developed to aid in development of improved wound healing strategies.

Undergraduate Student

Optimization of Bacterial Cell Culturing by Multiphysics Modeling

Primary Author: Lela Manis, Chemical Engineering

Advisor(s): Robby Sanders

Bacteria are often used as host cells for the propagation of plasmid DNA and recombinant proteins for applications in bioprocess, biomedical, and genetic engineering and biochemistry. To ensure that only bacteria of interest are growing, the solid media (i.e., agar) is sterilized at 121Â°C and prepared in the presence of specific quantities of particular antibiotics during cooling. The cooled temperature at which the antibiotic is added to the media is crucial due to the propensity of thermal degradation. Typical approaches to addressing this issue fail to incorporate cooling environments, and direct measurement can pose contamination risks.

A time dependent study of the heat transfer from sterilized media in the heated vessel to the environment has been conducted in COMSOL Multiphysics, coupling the kinetics of the thermal degradation of ampicillin or penicillin to viable antibiotic concentration. In effect, an optimal time to add the antibiotic is predicted. The vessel used to prepare agar is modeled as a beaker, and temperatures are predicted as the simulated agar cools to room temperature after which an average volume temperature and the final expected concentration of viable antibiotics over time are determined. The ease of determining accurate cooling times for agar preparation will allow for more precise concentrations of antibiotic in the agar, thus allowing for better experimental control in the quality and yield of product obtained from cell/bacteria cultures.

Undergraduate Student

Fluid Mechanics and Behavior of Natural Nonliving Organic Matter in Response to Shear

Primary Author: Kathlyn Mealio, Chemical Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Katherine Slamen; John Clark; Martha Wells, EnviroChem Services

Advisor(s): Holly Stretz

Nonliving natural organic matter (NNOM) is a common material found in environmental water that presents a fouling problem in water treatment membranes. Humic acid (HA) falls under the category of NNOM and displays dynamic particle size characteristics in response to factors such as shear rate, pH, ionic strength, and temperature. These variables have been hypothesized to impact the aggregation and disaggregation of NNOM. The behavior of NNOM found in pond water as a function of shear rate was investigated under constant 0.4 M CaCl2 concentrations. A rheometer was used to induce shearing of the NNOM in

the range of 10 to 400 sec-1. The Particle Size Distribution (PSD) displayed a complex relationship between shear rate and relaxation behavior. Non-Newtonian behavior of the sample(s) was also explored. Preliminary data shows the disappearance of certain size ranges at specific shear rates and colloidal behavior.

Undergraduate Student

Role of the Device Inclination on the Synthesis of Nanocomposite Gels

Primary Author: Renie Morrow, Chemical Engineering

Co-Author(s)/Collaborators: Phoebe Dawson

Advisor(s): Pedro Arce

Hydrogels as nanocomposite materials have achieved significant improvement in the field of bio-separation. Combining hydrogels with nanoparticles significantly enhanced the efficiency and selectivity of the separation process. Moreover, adding nanofillers to hydrogels significantly improved the physical, thermal, and mechanical properties of the nanocomposite hydrogel in comparison with “regular” ones. Previously, Sodium Dodecyl Sulfate (SDS)-micelles have been added to polyacrylamide gel, as a nanocomposite template, used in protein gel electrophoresis for separating proteins with polyacrylamide gel electrophoresis (SDS-PAGE) which is a widely used technique. In a recent exploratory study, an improved protein separation by electrophoresis was achieved by incorporating SDS micelles within polyacrylamide gel in varying concentrations. The SDS micelles were used to alter the internal porosity of polyacrylamide gels in order to achieve better resolution of the proteinâ€™s separation from the mixture. Therefore, understanding the effect of polymerization conditions on hydrogel structural properties is very important. The goal of this study is to investigate the role of the polymerization angle of gel casting system on the distribution of the nanoparticles within polyacrylamide gel. Preliminary results of this project will show the influence of device inclination through gelation process on the uniformity and the performance of the nanocomposite hydrogel.

Undergraduate Student

A Renaissance Foundry Model Approach to Developing a Fundamental Understanding of Bio-fluid Mixing

Primary Author: Russell Perry, Chemical Engineering

Advisor(s): Pedro Arce

In the domain of bioprocess engineering, mixing is a foundational aspect that requires concepts at the interface of rheology, fluid mechanics, and mass transfer. In practical aspects, mixing has been employed in physics and engineering fields and, although it has been extensively researched (Ottino, 1989, pp. 56-67), areas in bioprocess engineering need additional work. This leads to gaps in understanding mixing as it applies to, for example, the formation of fibril-based hydrogels. Improving comprehension of mixing requires use of complementary approaches including exercises such as simulation, experimentation, and analytical solution methodologies. This parallel learning approach emphasizes a pedagogical strategy to guide students in building an understanding via the Renaissance Foundry Model which provides a model for the acquisition and transfer of information and knowledge and is the foundation upon which a method is established. The approach provides the opportunity for specifications, limitations, scope, and scale of research to develop a preliminary understanding of mixing. The model adapts to the student goals in promoting and understanding key concepts such as scale of research, rheology, fluid mechanics, mass transfer, and reaction kinetics. At its core, this model provides organization to guide the collection and analysis of information to create a basic understanding

of mixing, and further expansion under the direction of the model can advance this understanding.

Undergraduate Student

Dynamic Behavior Patterns of Particle Size Distribution of Dissolved Organic Carbon

Primary Author: Katherine Slamen, Chemical Engineering

Co-Author(s)/Collaborators: Kathlyn N. Mealio; Holly Stretz, Tennessee Tech University; Martha Wells, Envirochem Services

Advisor(s): Holly Stretz

Humic acid (HA) is nonliving natural organic matter (NNOM) and exhibits dynamic behavior under certain shear conditions. This dynamic behavior presents a problem in water treatment as HA is a foulant and tends to disaggregate in turbulence and aggregate in the absence. The relationship between the aggregation time of NNOM found in pond water as a function of shear rate was investigated under constant 0.4 M CaCl2 concentrations. A rheometer (TA Instruments, Discovery HR 10) with a cup and bob attachment (TA Instruments, Peltier Concentric Cylinder) was utilized to induce shearing of NNOM in the range of 10 to 400 sec-1. Dynamic light scattering (DLS) was used to determine particle size distribution (PSD) patterns as the sample was allowed to relax over 120 minutes. The dynamic behavior of particles at ranges of 68.1-78.8nm, 396-459nm, and 4.8-5.56Âµm was explored. Additional data analysis suggests that there may be relationships between the increase or decrease of specific particles intensity or volume percentage, which were exposed to very specific shear rates.

Undergraduate Student

The Syllabus as an Agreement of Cooperation for Course Learning: A Student Perspective

Primary Author: Isabella Southerland, Chemical Engineering

Advisor(s): Pedro Arce

As a student, the course syllabus has traditionally been the most critical document to guide the semester. On the first day of class, the students receive a rigid syllabus for the course, the learning objectives, and the way the course will be evaluated and managed. Most educators do not stray from the original document, with strict schedules, grading scales, and policies for the course. Many times, the students feel that the syllabus is not favorable for their success in the course. The lack of communication, between instructor and student, can cause things like schedule conflicts, lack of background knowledge, learning styles, and many other issues. This is where there is an opportunity for improvement of the syllabus. A collaborative approach would allow for the exchange of ideas between students and the instructor in developing an agreement based on the class information and student input, as well as a collaborative and integrative syllabus, which incorporates student feedback and the instructor's framework. The collective thought of the class should be considered, as well as the perspective of the educator. It is crucial for both instructor and student to be on the same page, which is what this approach stems from. The most important characteristic is identifying the responsibility and workload that each task outlined in the syllabus requires. This poster will show the integration of a students' point of view as to why an agreement is favorable as well as future works.

Undergraduate Student

Understanding Hyperthermia Treatments in Cancer Tumor Applications: Fundamentals, Technology, and Preliminary Heat Transfer Modeling

Primary Author: Hannah Thomas, Chemical Engineering

Co-Author(s)/Collaborators: Sahera Abumariam; Daniel Braun

Advisor(s): Pedro E. Arce

Hyperthermia is a method of treatment for cancer tumors in which bodily tissue is heated to temperatures as high as 45 degrees C in order to destroy and kill cancer cells while causing little or no injury to healthy tissue. This research project has a threefold goal approach: One goal of this research is to review the literature and understand the different types of tumors and their characteristics, e.g. porosity, shape, and geometry. The second goal is to review and present a classification of the different types of hyperthermia technologies to treat suitable tumors and briefly describe their key physical information. The third goal is to analyze the heat transfer process present in the treatment of the tumor and understand its key role. We are addressing research with a foundation in engineering, biology, and physics. Using the Renaissance Foundry model, Newton's Law of Cooling, Fourier's Law, and the Bioheat equation, a suitable quantity of energy can be directed as needed, based on the tumor's dimensions. In this case, the length will be the independent variable to consider. To cure the tumor, the longer the length, the more heat transfer area is necessary. Based on literary research, the evidence suggests that with a proper understanding of heat transfer and the usage of hyperthermia for cancer treatment, these methods can be applied and further perfected for clinical use.

Undergraduate Student

A Survey Overviewing Technological Aspects of Wastewater Treatment Facilities in the State of Tennessee-Preliminary Observations

Primary Author: Diego Bautista, Chemical Engineering

Co-Author(s)/Collaborators: Claire Myers; Luke Horne; Dipendra Wagale; Robby Sanders

Advisor(s): Pedro Arce

Wastewater is produced from several industrial, business, and anthropogenic. It contains microbes, pathogens, and several other organic and inorganic substances that are harmful to the environment and that must be removed before the water can safely be returned to receiving streams. This sewage is pumped to the cleaning facilities through the drainage system. The cleaning facilities called wastewater treatment plants are operated in the cities at different capacities suitable to handle the water volume that needs treatment. Although all these facilities display a basically similar wastewater treatment process, there exists a few variations depending upon the capacities, location, cost of operation, served populations and type/amount of contaminants required to remove.

In this study a comprehensive report illustrating the different aspects of WWTPs in the State of Tennessee will be drafted. This report will include evaluating and summarizing the methods adapted by different WWTPs: For example, some implement chlorination methods in tertiary treatment unit. The research will also include a classification based on similarities and differences between the methods adapted by these plants and recommend some potentially novel technologies. These may be susceptible of upscaling and be adaptable to treat sewage more effective and be cost efficient. We believe that the outcome of this research will be a useful information for potentially improving sewage treatment across Tennessee.

Department of Civil and Environmental Engineering

M.S.

Investigation of Advanced Non-Circular Slip Surfaces for Slopes

Primary Author: Dylan Alissandrello, Civil and Environmental Engineering M.S.

Advisor(s): Daniel VandenBerge

As technology has advanced over the past years, the slip surfaces analyzed during the design of slopes have become more advanced compared to the basic circular surfaces used in earlier years. While this has been happening, the slopes that were designed with the simpler circular methods and then re-evaluated with these new more complex non-circular methods are shown to have a lower factor of safety during re-evaluation. This then incites the question of what does this mean for engineering design? If we can prove that the more complex non-circular slip surface methods are more accurate, then a possible shift to a lower design factor of safety may be required. This would not mean that the slope is less stable, but that the methods to analyze these slopes have become more accurate; therefore, a higher factor of safety in design is not required.

In order to investigate this and be able to verify results, the use of case studies is being implemented. These case studies give us soil information and design information, which can be remodeled in software and then analyzed using the different non-circular slip surface method. These can then be compared to the equivalent results of common circular methods. This research is still ongoing, but during early stages, there have been “critical” inputs that must be acknowledged, as they will drastically affect the calculated factor of safety for the slope being analyzed.

M.S.

Flood Risk Education in the Trace Creek Watershed Using HEC-RAS and ARCGIS Story Maps

Primary Author: Brady England, Civil and Environmental Engineering M.S.

Co-Author(s)/Collaborators: Maci Arms; John Brackins

Advisor(s): Alfred Kalyanapu

Flooding is an issue that affects communities in the United States and abroad. One such community that was recently impacted by flooding was Waverly, Tennessee. Located in the Trace Creek Watershed, Waverly and the surrounding areas experienced high levels of precipitation in August 2021, leading to major flooding. The impact of the flood was especially felt by this economically disadvantaged community. While prediction efforts could have helped reduce the impact of the flood, Waverly and the surrounding area have limited data required for hydraulic and hydrologic modelling. The goal of this project is to provide an educational tool for the people living in the flood prone areas to have a better understanding of how flooding accumulates and the potential areas of risk using the Trace Creek watershed as a case study.

M.S.

A Practical Approach for Using Advanced Soil Constitutive Models by the Use of Parameters from Mohr-Coulomb Model

Primary Author: Alireza Shiri, Civil and Environmental Engineering M.S.

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

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Daniel VandenBerge

Advisor(s): Daniel VandenBerge

The primary objective of the current research was to develop a new method for utilizing the advanced soil constitutive models alongside the simple soil constitutive models used in everyday calculations of geotechnical engineers. In order to achieve this purpose, two advanced soil constitutive models: (1) Plastic Hardening Model and (2) Modified Cam-clay model are introduced. Then, the methods and procedures that are used to derive the parameters of these models are described. Finally, a comprehensive and applicable procedure is introduced to use these advanced models while having the parameter values of simple Mohr-Coulomb model.

Undergraduate Student

Microplastics Sampling and Identification in Wastewater Treatment Plants around Middle Tennessee

Primary Author: Caroline Hitchcock, Civil and Environmental Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

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

Advisor(s): Tania Datta

Recent research has shown that microplastics (MPs) are present ubiquitously in natural and drinking water systems. One of the possible sources of MPs are municipal wastewater treatment plants (WWTPs). Because of their key role in maintaining public health, WWTPs can give insight into how much MPs are being disposed by human activities, and if existing treatment plants can process these emerging pollutants. The goal of the research study was to address the inconsistencies present in other research methodologies by determining the efficacies of collection and preparation methods for MPs in wastewater. In order to accomplish this, samples were collected via grab, composite, and pump filtration from two WWTPs in middle Tennessee to be processed and analyzed. The facilities chosen for this study were selected to account for variables such as population density, hydraulic capacity, treatment processes, and receiving streams where wastewater effluent is discharged. Through experimentation, this study will process the samples using hydrogen peroxide oxidation and zinc chloride density separation. The future outcomes from analysis of the collected and processed samples using epifluorescence microscopy and Fourier transform infrared spectroscopy to quantify and identify MPs will give results to the adequacy of research methodologies for the overall goal of understanding the fate of MPs in WWTPs.

Department of Computer Science

M.S.

Diagnostic Prediction using Clinical Text Analysis

Primary Author: Sharanya Aavunoori, Computer Science M.S.

Advisor(s): William Eberle

Abstract: Interpreting symptoms plays an important role in determining whether your medical diagnosis is accurate. Learning and assessing the skill of writing patient notes requires feedback from other doctors, a time-intensive process that could be improved with the addition of machine learning. Clinical Skills exam is an important part of United States Medical Licensing Examination (USMLE). In this the test takers are required to interact with standardized patients and write a patient note. Trained physicians scores them based on a rubric that are outlined for each case's important concepts. Approaches using natural language processing have been created to address this problem, but patient notes can still be challenging to interpret computationally because features may be expressed in many ways. In this project we will develop an automated method to map clinical concepts like “diminished appetite” to various ways in which these concepts are expressed in clinical patient notes written (“eating less”, “clothes fit looser”). we aim at predicting the diagnostics, which helps doctors in diagnosing a patient’s ailment using the anamnesis provided. We will use NLP methods to classify and label the data based on the clinical concepts.

M.S.

Polyglot Detection Using Machine Learning

Primary Author: Mary Adkisson, Computer Science M.S.
Advisor(s): Maanak Gupta

Malware is software designed to intentionally harm computer systems. Common methods of malware delivery rely on the system user to click a link or open an email attachment. Malware protection tools do exist for detecting malicious files. However, one file type, a polyglot, can evade basic detection. A polyglot is a file that is valid as more than one file type. In our project, we scanned the entire contents of files before making a decision about type, in order to attempt to detect polyglots among single type files. We used binary classification with various machine learning algorithms to learn how to assign a label to given file input. We compared the accuracy and speed of five classification models for training and testing: Random Forest, Support Vector Classification, Stochastic Gradient Descent, Gradient Boosting, and Catboosting. Using our collection of 9,574 files, we ran these models in the range of 0.112- 492 seconds, with an accuracy range of 91.2%-100%, depending on the algorithm. Our results showed that the optimal algorithm was Random Forest: it trained in 1.09 seconds and was 100% accurate. By successfully labeling file types, we can improve security in file downloads and malware scanners. This work was one task completed towards a greater polyglot research project created by Oak Ridge National Laboratory.

M.S.

COVID-19 Occurance Prediction

Primary Author: Anjana Ashokkumar, Computer Science M.S.

Advisor(s): William Eberle

Unfortunately, Covid-19 has become the new normal of human existence. As a result of the pandemic lives have been lost and health of millions has been impacted. Trying to predict the prevalence of the virus in and around the regions where it is prevalent will help people in those areas or neighborhoods be cautious. This could also help the governments of each country, to be more aware of the virus widespread areas, and in turn protect lives of

people. In this paper, we will be predicting the occurrence of Covid-19 by using geo spatial data, as well as data containing affected cases counts, death cases counts, and recovery cases counts of every country. Through data mining techniques, the data is preprocessed for errors or missing data and then classification and clustering analysis are used for prediction of the disease. Our hope is that these results will aide health workers in predicting the future case rate of covid-19, and the intensity of the disease in each country.

M.S.

Data Clustering for Categorizing Normal and Unusual IoT Network Traffic to Identify Attacks

Primary Author: Elena Becker, Computer Science

Advisor(s): Maanak Gupta

Internet of Things (IoT) devices are becoming increasingly prevalent as time goes on, as they present a means of connectivity that is both straightforward and efficient for the end user. These devices are being used everywhere, like in homes, businesses, and people's pockets. Because of the amount of connectivity that they allow, network traffic security is a growing concern, especially as the devices become used in more sensitive environments. Data clustering, a machine learning technique used to group data points, is one solution to aid in classifying network data. By organizing network traffic as normal or unusual, direct and indirect attacks can be identified. This paper will compare the use of various data clustering algorithms to aid in analyzing IoT network traffic and determine if an attack was attempted or not.

M.S.

The Differences in Probability of Reusing User Aliases Between the Surfaceweb and Darkweb

Primary Author: Tymothy Brandel, Computer Science

Advisor(s): William Eberle

As users change merchant platforms or those platforms cease to exist, on the dark web or surface web, many users must debate reusing an alias from their previous marketplace. The dark web specifically has more volatile platforms and wider concern for privacy that could influence user behavior. The goal of this paper is to produce a model that can predict the probability a user will keep their alias from one platform to another. Whether they use the same alias or not is dictated by many factors such as privacy, availability, reputation and more. In this paper, we use datasets from surface web and dark web services to distinguish users with personally identifiable information (PII) such as addresses, names, locations of products being sent to and from, and possibly more. Once these attributes have been obtained, they will be compared from one instance of that alias to another to determine how likely it is the same user. Similar studies focus on one platform but within this paper we will focus on an alias across multiple platforms.

M.S.

Using Graph-based Knowledge Discovery to Detect Anomalous Patterns in Crime Data

Primary Author: Matthew Brotherton, Computer Science M.S.

Advisor(s): William Eberle

The naive approach to law enforcement is purely reaction-based. However, more effective preemption of criminal acts is made possible by analyzing datasets comprised of previous incidents; attributes such as time, location, and other specifics of the event serve as crucial details for predicting reoccurrences. Graphs are an appropriate approach for representing these elements, as they can provide structure and emphasize relationships that other techniques may fail to. In addition, graphs can highlight an underlying hierarchy between subjects if one is present. In

particular, the Tucson Police Department has made their recent crime archives publicly available. Data from 2018 until the present is readily downloadable for modification, cleaning, and analysis. This dataset will allow data scientists to supplement law enforcement with predictive tools and a clearer picture of the threats they face. This, in turn, will help the TPD allocate resources where they are needed most.

M.S.

Data Profiling Phishing URLs to Find the Most Impactful Attributes

Primary Author: Kaitlyn Cottrell, Computer Science M.S.

Advisor(s): William Eberle

Phishing is a common form of social engineering attack where an attacker crafts a malicious link, under the guise of a reputable source, that ultimately leads to a fraudulent website. The purpose of the fake website is to trick the user into entering personal or sensitive information, like account credentials, credit card numbers, or bank details. Phishing websites are becoming increasingly sophisticated and difficult to spot, especially due to the lack of user security training in most cases. Therefore, it is important to identify the most common attributes associated with the fraudulent URLs utilized in phishing attacks. A simple way to do this is data profiling, or reviewing source data, examining the structure and content, and identifying useful points to summarize the whole. This paper will utilize data profiling to analyze multiple phishing website datasets and locate the most impactful and easily identifiable features for recognizing if a URL is legitimate or not. The features found should be able to assist security professionals and nonprofessionals alike in identifying phishing websites.

M.S.

Predicting Board Game Ratings

Primary Author: David Feier, Computer Science M.S.

Advisor(s): William Eberle

In this project, we are going to look at data about board games, taken from Kaggle. Our objective is to examine and classify board game data using multiple classification and clustering techniques. We will train our models on the provided data set, and then run the models to attempt to answer the following questions: What criteria makes it successful: money made, amount sold, number of people who bought, number of positive reviews, etc.? Is there a relationship between the volume sold to the number of reviews of the game? We will also look at other related questions. The goal of this is to help predict a board game's performance and rating to potentially help determine if the board game will be a success and worth pursuing or not.

M.S.

Quantum Teleportation with Enhanced and Secure Control Features

Primary Author: Jesse Holland, Computer Science M.S.

Advisor(s): Muhammad Ismail

Development into a quantum internet has begun. Although still early on, progress is being made and quantum networking protocols are being proposed. Currently, researchers have a focus on controlled quantum teleportation as a primary means of sending quantum information between parties under the control of a moderator (network administrator) over the communication. For this network administrator, named Charlie, to properly act as a moderator, their control over the teleportation must be as strong as possible. We will show that by hiding the classical information being sent from Charlie to the end-user within a superposition, Charlie's control over the communication can be improved. This decreases the likelihood of the user's attempt to teleport the quantum information without Charlie's

consent. In total, the process requires three qubits, two quantum channels, and two classical bits be added to existing implementations. Additional entanglement sharing is not necessary. Our proposed technique also addresses security concerns that could arise while sending the classical control information from Charlie using traditional methods.

M.S.

Predicting Winners of Big Brother Using Predictive Methods of Data Mining

Primary Author: Allyson Jones, Computer Science M.S.

Advisor(s): William Eberle

Data mining techniques such as classification methods can be used to predict the value of a variable based on other attributes in the same dataset. Prediction models can be used on data like sporting statistics and political polls. One area that prediction has not crossed over into yet is reality television. These shows have winners, many seasons, lots of contestants, and even more information about the players released to the public before the show starts. A great example of this is Big Brother. Before every season, each contestant completes pre-season interviews with the producers, and these answers are released to the public. This information, along with their demographic information, could be used to predict the winner before one player steps foot into the house. Ideally, a dataset would already exist with all this information on each contestant of Big Brother, but it does not. Therefore, the first step needs to be creating this dataset. After this happens, testing can begin. This dataset would be tested with prediction models, specifically classification methods. Once the testing begins, any data revision can occur. For example, if there is not enough data, information about contestants from Big Brother Canada and Big Brother UK can be added to the dataset. Hopefully, in the end, a model will be able to correctly identify a winner, or future winner, of Big Brother.

M.S.

Generating Explanations for Machine Learning Based Malware Detection Using SHAP

Primary Author: Jeffrey Kimmell, Computer Science

Co-Author(s)/Collaborators: Maanak Gupta, Tennessee Technological University; Mahmoud Abdelsalam, North Carolina A&T University

Advisor(s): Maanak Gupta

In recent years, researchers have been analyzing the effectiveness of machine learning models for malware detection. These approaches have ranged from methods such as decision trees and clustering methods, to more complex approaches like support vector machines and neural networks. It is relatively well accepted that for most use cases in this domain, neural networks are the superior approach. This, however, comes with a caveat. Neural networks are notoriously complex, therefore, the decisions that they make are often just accepted without questioning why the model made that specific decision. The black box characteristic of neural networks have challenged researchers to explore methods to explain neural networks and their decision making process. In this work, we deploy the SHAP explainable machine learning approach on a collection of machine learning methods to show why these models make the decisions that they do and which features are the main contributors to these decisions.

M.S.

Predicting PGA Tournament Outcomes

Primary Author: Jeffrey Kimmell, Computer Science

Advisor(s): William Eberle

With the explosion in the popularity of golf and sports

betting, sports analysts have attempted to predict outcomes of golf tournaments based on statistical data. Many sports fans and analysts feel that golf is a game that can not be accurately predicted. However, professional golfers are not like your everyday amateur golfer, their high level of skill and consistency gives data scientists a better chance of predicting how the results of a professional golf tournament can unfold. In recent years, there has been a large push for collecting more data in regards to player performance on the PGA Tour with the introduction of ShotLink, which is the PGA Tour's proprietary method for collecting player statistics. This development has led to a massive amount of available statistics for analysts and data scientists to consider when predicting tournament outcomes. While this is a great advancement for the game of golf, it has also led to an overwhelming flood of data that can muddle the big picture of players' performances. This work will provide visualizations of critical player statistics as well as consider the statistics of each individual course the tour visits in order to determine a group of players that will perform well at each PGA Tour event.

M.S.

Classifying Covid-19 X-Rays and Exploring the Relationships of Associated Data

Primary Author: Charlie Lester, Computer Science M.S.
Advisor(s): William Eberle

Image classification techniques using machine learning are proving to be very efficient in classifying medical images. In this paper we will look at a public Covid-19 Image dataset accompanied by clinical data to see what we can learn from our data. The data being used is a publicly available data set of labeled chest X-Ray images along with clinical data which includes parameters such as age, gender, diagnosis, and clinical notes. Using this data, we will answer some of the following questions. What is the performance difference of popular ML models including CNNs, SVMs and KNNs? What relationships exist in the parameters found in the clinical data? Can we successfully classify other features in our dataset? Can we use a multimodal approach to increase our model performance? We will be using AUC-ROC curve to validate our findings

M.S.

Protected Spreadsheet Container with Data

Primary Author: Bradley Northern, Engineering M.S.

Co-Author(s)/Collaborators: Vadim Kholodilo; Denis Ulybyshev

Advisor(s): Denis Ulybyshev

We developed a a PROtected SPrEadsheet Container with Data (PROSPECD), which guarantees data confidentiality and integrity, as well as fine-grained role-based and attribute-based access control. It stores data together with access control policies in a protected form and enables decentralized policy enforcement. Furthermore, PROSPECD has data leakage detection capabilities and is compatible with Microsoft® Excel®, which makes the integration with existing IT infrastructures easier. PROSPECD data can be accessed by authorized parties either in a client-side desktop application, or in a client-side Microsoft® Excel® Add-in, or in a remote web viewer. Regular expressions are supported in access control policies, which enables the content-based access control for individual data items.

Our solution also proposes a novel on-the-fly key derivation function, in which it generates the decryption key using AES 256-CBC, every time data is requested. This scheme takes three main inputs: a SHA-256 hash of our Authentication Servers' private key, a data worksheet name, and another hash of our access control worksheet. This provides integrity of access control policies and prevents any unauthorized modifications.

PROSPECD can be used to store and distribute Electronic Health Records (EHRs) and sensor data in Cyber-Physical

Systems. It allows healthcare providers to send EHRs with clinical and administrative data over non HIPAA-compliant communication channels, e.g. via emails.

M.S.

Detecting Cyber Attacks using the Matrix Profile

Primary Author: Sina Sontowski, Computer Science M.S.

Co-Author(s)/Collaborators: Maanak Gupta

Advisor(s): William Eberle

Cyber-attacks have been increasing in recent years and are becoming a threat to IoT infrastructures. Anomaly Detection can detect the attacks earlier and form an early warning system. In this work, the overall goal is to detect Denial of Service (DoS) attacks aimed against a Smart Farming Infrastructure. We are using the Matrix Profile (MP) for anomaly detection on network traffic data that has been collected during a deauthentication attack. The MP is a data structure developed by Eamonn Keogh for time series analysis. While past work has used machine learning anomaly detection approaches such as Autoencoder on network traffic, no other work has applied the MP on network traffic data for anomaly detection of cyber-attacks. Since the dataset is labeled, we will evaluate our method using standard anomaly detection metrics including accuracy, precision, F1, and recall.

M.S.

Mining Vehicle CAN Logs for Relationships Between Message Sequences

Primary Author: Zachariah Threet, Computer Science M.S.

Advisor(s): William Eberle

To protect themselves from hackers and competitors, automotive vehicle manufacturers obfuscate the Control Area Network (CAN) data being sent over their vehicle's internal networks. The rules used to obfuscate the data differ between the makes and models of today's vehicles. The inability to understand message semantics has become a major inhibitor to developing techniques for vehicle security and other types of automotive research. No small amount of research has been done to decode the obfuscation rules, but up until this point each researcher has primarily had to design their work independent of the work done by their predecessors. Further, to the best of our knowledge, no attempts to derive semantic meanings of messages have focused on the sequence that messages occur in. In the project, we utilized various data mining techniques to derive sequence rules from logs of recorded CAN messages. We use the decoding rules for a Tesla Model 3 to understand the relationship between the definitions of CAN messages and the order they occur in for the Tesla. The models that we create can be used in the future to extract general relationships between mapped CAN data and the sequence those messages occur in that can later be used to understand unmapped data. Additionally, using synthetic data, we show how these models can identify anomalies within the vehicle that might indicate intrusion or malfunction of the vehicle.

M.S.

Calculating Binary-Address Distance Between Functions: A New Approach to Rare Itemset Mining

Primary Author: Austin Tice, Computer Science M.S.

Advisor(s): William Eberle

Programs commonly follow many implicit programming rules, most of which are not defined by developers. As a security analyst, it is vital to understand and discover these implicit rules. Previous work on this topic has dealt specifically with itemsets that have an arbitrarily large support, which then produces fewer false positives.

However, in many cases it can be trivial to determine implicit rules for itemsets with a high support. Within these tools there are many instances where a particular itemset of low support may not be determined to be actionable and therefore disregarded. This paper proposes a new, automated method to solve the issue of finding implicit programming rules with low support, namely Rare Itemsets, by adding an additional heuristic that computes the binary-address distance between functions of interest. Motivation for this research comes from the stance that it will improve the speed at which reverse engineers and vulnerability researchers can find software vulnerabilities in programs.

M.S.

Secure Monitoring and Notification System for Cloud Infrastructures

Primary Author: Rumi Ujiie, Computer Science M.S.

Co-Author(s)/Collaborators: Vadim Kholodilo; Bradley Northern; Denis Ulybyshev

Advisor(s): Denis Ulybyshev

Data breach costs rose to USD 4.24 million in 2021 which was the highest average total cost in the past 17 years. Since cloud infrastructures are widely used, a monitoring system is necessary to detect problems at early stages and send alerts to cloud owners, which would reduce the cost of data breaches. We developed a monitoring solution for Amazon EC2 cloud infrastructure. Our implementation can detect several types of issues in the cloud. This is done by collecting statistics and sending alerts, as well as log files, to the owner in a protected form. Our approach provides data confidentiality, integrity, and origin integrity for cloud notifications and alerts, which can be sent via emails or in popular messengers, such as Slack or Microsoft Teams. We integrated our approach with the open-source monitoring system "Prometheus", which enables our solution for other cloud platforms.

M.S.

Finding Patterns in The Music City

Primary Author: Brandon Vandergriff, Computer Science M.S.

Advisor(s): William Eberle

As we enter the waning side of the COVID-19 pandemic, global tourism and traveling has begun to grow again. Between 2020 and 2021, global tourism raised 4% from 400 million to 415 million. The United States saw almost 20 million international travelers during the pandemic. Including domestic travelers, tourism is a pillar for our economy. With tourism, finding a place to stay is crucial to any trip. With 7 million listings found across the world, Airbnb enables tourists to rent accommodations in specific locales. Using the Nashville 2021 dataset found at InsideAirbnb, we can apply data mining and machine learning techniques to aide the tourism industry. The dataset offers geo-location of every Airbnb in Nashville, along with the price and minimum stay length. Our first approach, we use regression to predict prices given different features about the Airbnb. The accuracy of the predictions are compared to the original, and are given a rating based on the comparison. Our second approach acts as a “related” recommender. Using clustering techniques, we explore the capability to discover similarities between Airbnbs, and suggest similar ones to the tourist. For the second data subset, sentiment analysis and word frequency is used on individual Airbnb’s comments. We then build a “average sentiment” value to summarize the comments. Word frequency is used to figure out what common words are used across reviews for an Airbnb.

Ph.D.

Understanding the Structural Similarities and Dissimilarities of Cryptographic Ransomware using

Static Analysis

Primary Author: Md. Ahsan Ayub, Engineering Ph.D.

Advisor(s): Ambareen Siraj

As ransomware threats are rapidly increasing, its cost on both national and global scales is becoming significantly high as evidenced by the recent events. Ransomware carries out an irreversible encryption process, where it encrypts victims' digital assets to demand financial compensation. Adversaries utilize different means to gain initial access to the target machines, such as phishing emails, vulnerable public-facing software, Remote Desktop Protocol (RDP), brute-force attacks, and stolen accounts. To address these issues, this research aims to identify structural similarities among a long set of ransomware variants using static analysis. Additionally, we compare the differences of such identified similarities against benign applications. With our domain knowledge and exploratory data analysis tasks, a list of suspicious indicators is observed in the portable executable (PE) metadata of all the ransomware samples. We reduce the dimensionality of the generated dataset by using the Principal Component Analysis (PCA) technique and leverage the one-class classification algorithms to learn the common data boundary in the ransomware's structural information. To find the structural dissimilarities, a few machine learning algorithms are selected to perform the binary classification tasks. Our research is focused to aid the preventative measurements in the fight against ransomware when it infects the victim's Windows machine.

Ph.D.

A Simple, Direct Uncertainty Quantification Technique Using Machine Learning Regression

Primary Author: Katherine Brown, Engineering Ph.D.

Advisor(s): Doug Talbert

Epistemic uncertainty quantification provides useful insight into both deep and shallow neural networks' understanding of the relationships between their training distributions and unseen instances and can serve as an estimate of classification confidence. Bayesian-based approaches have been shown to quantify this relationship better than softmax probabilities. Unfortunately, however, those approaches to uncertainty quantification require multiple Monte-Carlo samplings of a neural network, augmenting the neural network to learn distributions for its weights, or utilizing an ensemble of neural networks. Current research has yielded several techniques that estimate uncertainty deterministically but tend to struggle in independent evaluation using real-world data and tasks compared to stochastic, or variational, techniques such as Bayesian dropout. In this work, we propose a technique that allows Bayesian dropout uncertainty to be estimated using learned regression algorithms such as decision trees, neural networks, and extreme gradient boosting trees. We find that this technique, once trained, allows dropout uncertainty to be effectively and efficiently predicted.

Ph.D.

Bayesian Belief Network for Heart Disease Prediction

Primary Author: Moumita Kamal, Engineering Ph.D.

Advisor(s): Doug Talbert

With millions of people dying of Cardiovascular diseases (CVDs) annually, the application of Artificial Intelligence in the prediction and diagnosis of these diseases has become essential. Researchers have used various Machine Learning techniques to predict heart diseases in patients. Bayesian Belief Networks (BBN) are often used as a popular technique for disease prediction and diagnosis because of their interpretability and flexibility. However, not much work has been done on heart disease prediction using BBN. In this paper, we use Bayesian Belief Networks to predict the likelihood of cardiovascular diseases in patients. The proposed model takes patient information

on different risk factors associated with cardiovascular diseases and builds a Bayesian Belief Network that predicts the likelihood of heart diseases in people.

Ph.D.

Online Guard: Identifying the Misinformation in Social Media and Its Impact on COVID-19 Vaccination Progress in Different Countries

Primary Author: Sanjida Akter Sharna, Engineering Ph.D.

Co-Author(s)/Collaborators: William Eberle

Advisor(s): William Eberle

The emergence of the novel coronavirus pandemic has caused a myriad of problems worldwide. One such problem is misinformation, which in itself should be considered a risk. Since the outbreak of the COVID-19 pandemic, popular social media platforms are flooded by exaggerated phony news which is affecting our society, well-being and public safety. Many of the online falsehoods don't have apparent sources or intentions, rather, some niche groups often start mobilizing to endorse their agendas through the rumors. Although the pertinent tools and existing techniques can support fact-checking and identification of conspiracy, misinformation and negative sentiment at various stages, a complete end-to-end solution is complicated. In this paper, we propose a thorough analysis and identification system named Online Guard using natural language processing tools and supervised learning techniques to identify the relationship between misinformation from the negative sentiment of COVID-19 vaccine-related tweets and vaccination progress rate and its impact in different countries. For this purpose, we will use a COVID-19 all vaccines tweet dataset to identify and analyze misinformation, and another dataset named country vaccination that shows vaccine rollout and vaccination progress in different countries. The aim of this project is to identify the relationship between spreading misinformation, negative emotions on Twitter, and its impact on vaccination progress for a particular time period.

Ph.D.

Estimating the Condition of Streams & Rivers: An Approach using Supervised Learning Methodologies

Primary Author: Daniel Adams, Environmental Sciences Ph.D.

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Advisor(s): William Eberle

Conservation efforts are ongoing by various state and federal agencies to improve the health, function, and connectivity of southeastern ecosystems by 10% by 2060. One mechanism for achieving this goal is by looking for where the opportunities to improve the network of lands and waters through land management practices, in the context of wildlife species sustainment. In this study, a habitat system condition index is developed and modeled to be representative of the relative departure of a current wildlife habitat condition from a desired condition to identify where there are conservation opportunities available across the landscape. The resulting index could be used to inform decision makers on where to conduct habitat specific conservation projects. Similar efforts in landscape scale ecology to produce condition indices commonly use an expert system modeling approach or a multi-criterion decision making method. This study explores the application of supervised learning methodologies to produce a more accurate and flexible index that is assessed using elicited field expertise knowledge and continuously validated through its usage by conservation practitioners. Due to the novelty of this approach, this paper discusses the methodologies used to solicit and digitize field knowledge expertise to create the training dataset used.

Ph.D.

An Approach Towards Consumer Power Usage Pattern Using Classification Technique

Primary Author: Shampa Banik, Engineering Ph.D.

Advisor(s): William Eberle

Today's life is embedded with technology that consumes an enormous amount of electricity. To maintain the uninterrupted electricity supply, keeping track of the consumer demand pattern is a dire necessity, particularly in the case of the smart grid system. Using a load usage pattern as well as the timing of peak electricity usage, an approach is proposed in this paper to estimate energy consumption patterns for residential and industrial consumers. Although in past, tariff structures were mainly applied on the kind of activity among consumers, the kind of activity and electrical behavior of the customer has a very poor relationship. Applying clustering techniques to classify customers according to load curves is more efficient. This paper proposes a two-fold classification algorithm followed by a supervised learning technique to classify electric customers. At First, results are obtained from the classification techniques and compared. A decision matrix is projected to reach the goal of predicting power consumption behavior in the second phase.

Ph.D.

Data Mining for Cardiovascular Disease Prediction

Primary Author: Islam Elgarhy, Engineering Ph.D.

Advisor(s): William Eberle

Cardiovascular diseases (CVDs) are disorders of the heart and blood vessels and are a major cause of disability and early death worldwide. For example, in the USA, one person dies every 36 seconds due to CVDs. In addition, it affects national income due to the cost of health care services, medicines, and lost productivity due to death. It's important to early notification for the individual at higher risk of developing CVD to prevent early deaths. Most often it's challenging for medical practitioners to predict cardiovascular disease as it requires experience and knowledge. The advances in the field of computational intelligence, together with the massive amount of data produced every day in clinical settings, have made it possible to create recognition systems capable of predicting whether an individual has CVD. Support Vector Machine (SVM), and Convolutional Neural Network (CNN) will be used to train on the Kaggle dataset of CVD cases, which includes 70000 registers of patients and 12 attributes divided into three types (Objective, Examination, and Subjective) considered relevant for identifying the disease. A feature weight is used to select which features are more useful in the training process in order to achieve a better accuracy.

Ph.D.

SecCAN-FD: A Next Generation Secure CAN Protocol

Primary Author: William Lambert, Engineering Ph.D.

Advisor(s): Sheikh Ghafoor

The Controller Area Network (CAN Bus) is the most popular in-vehicle communication network within modern commercial vehicles due to its affordable price, reduced weight, adherence to real-time requirements, and resilient fault-tolerance mechanism. Unlike Ethernet, CAN lacks a source and destination address and instead uses an arbitration identifier, with lower IDs indicating higher priority messages. However, CAN lacks basic security features such as encryption and authentication, and is therefore susceptible to attacks such as replay, masquerade, and denial-of-service (DoS) attacks. Researchers have proposed various methods of securing CAN including encryption schemes, intrusion detection systems, and firewalls. SecCAN [Ullah et. al.] is a secure CAN protocol that protects against both replay and masquerade attacks

but is susceptible to DoS and its proposed implementation is limited by the CAN protocol. Thus, we have designed SecCAN-FD, an improved version of SecCAN which will use CAN-FD, rather than CAN 2.0, to utilize its increased payload for enhanced lightweight encryption and authentication. Additionally, we are combining concepts from CANSentry [Humayed et. al.], a novel CAN firewall, to limit communication between ECUs exposed to attack surfaces and internal ECUs. To prevent targeted ID DoS attacks on legitimate arbitration IDs, a lightweight IDS component will monitor the frequency of messages originating from exposed ECUs.

Ph.D.

Graph Neural Network for Human Trajectory Forecasting

Primary Author: Elmahedi Mahalal, Engineering Ph.D.

Co-Author(s)/Collaborators: Muhammad Ismail

Advisor(s): William Eberle

Predicting human travel trajectories in complex dynamic environments play a critical role in various fields such as autonomous vehicles, intelligent robots, intelligent transportation systems, and also for wireless communication networks. In wireless communication, an accurate user trajectory forecast is crucial for resource allocation, energy efficiency, and quality of service improvement. Due to the high nonlinearity and the complexity of the user's walking behavior, traditional methods cannot satisfy the requirements of mid-and-long term prediction and often ignore spatial and temporal dependencies of each position. In this paper, we propose a novel deep learning framework approach based on Graph Neural networks and long short-term memory, to tackle the prediction problem in realistic human movement. Instead of applying regular convolutional and recurrent units, we formulate the problem on graphs and build the model with complete convolutional structures, which enable faster training with fewer parameters. Specifically, we are interested in predicting the future positions of the user motion given a history of the position for a collection of users trajectories. To train our model we are using the Edinburgh Informatics Forum Pedestrian Database (EIFPD). We apply data mining preprocessing techniques to achieve results that demonstrate where our approach outperforms previous work and show that our model effectively captures comprehensive spatio-temporal correlations.

Ph.D.

Activity Control: A Vision for "Active" Security Models for Smart Collaborative Systems

Primary Author: Tanjila Mawla, Engineering Ph.D.

Co-Author(s)/Collaborators: Maanak Gupta

Advisor(s): Maanak Gupta

Cyber physical ecosystem connects different intelligent devices over heterogeneous networks. Various operations are performed to support automation in smart environments. An Activity reflects the current state of an object, which changes in response to requested operations. Due to multiple running activities on different objects, it is critical to secure collaborative systems considering run-time decisions impacted due to related activities (and other parameters) supporting active enforcement of access control decisions. The activity-centric access control (ACAC) model (recently proposed) provides an active security approach that considers activity decision factors such as authorizations, obligations, conditions, and dependencies among related device activities. This paper takes a step forward and presents the core components of an ACAC model and compares with other security models differentiating novel properties of ACAC. We highlight how existing models do not (or in limited scope) support "active" decision in collaborative systems. We propose a hierarchy of a family of ACAC models by gradually adding

the properties related to activity and discuss states of an activity. We highlight the convergence of ACAC with Zero Trust tenets to reflect how ACAC supports the necessary security posture of distributed and connected smart ecosystems. This paper aims to gain a better understanding of ACAC in collaborative systems supporting novel abstractions, properties and requirements.

Ph.D.

Network Intrusion Detection and Attack Type Classification using Machine Learning

Primary Author: Tanjila Mawla, Engineering Ph.D.

Co-Author(s)/Collaborators: William Eberle

Advisor(s): William Eberle

In handling vulnerabilities in computer networks, Network Intrusion Detection System (NIDs) plays a vital role. Complex and time-varying network packets are flowing between connected networks and a large portion of the network data may remain normal whereas there is small portion of attack data that can be mixed. There are many kinds of network attacks. To detect and classify various kinds of attack data in network packets, machine learning algorithms are very popular and inevitable to be applied. We intend to use the NSL-KDD Dataset which was published in 2001 as an improvement to the KDD Cup 99 dataset where there are 24 different attack types mixed with normal data in the training set. There are 41 features for each of the data in the network dataset. In this work, we use machine learning algorithms to classify both normal and attack data. While there are many classification techniques, our goal is to increase the typical accuracy in detection and classification of network intrusions. To demonstrate the effectiveness of our approach, we present the confusion matrix that demonstrates accuracy, and include a graphical representation of the clusters in order to better visualize the classification of different types of attacks.

Ph.D.

Early Stage Prediction of Diabetes Risk Using Machine Learning

Primary Author: Mohamed Shaban, Engineering Ph.D.

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

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): William Eberle

Diabetes is one of the more fatal diseases in this world. Additionally, it is the reason behind a different range of disorders. For instance, blindness, urinary organ diseases, coronary failure, etc. Yet, while new technologies and scientific advancements have resulted in many diseases being cured around the world, some like diabetes can be prevented but not cured. Numerous data mining approaches, using techniques such as K-Nearest Neighbor Algorithm, Logistic Regression Algorithm, and Random Forest Algorithm, have been applied in this domain for the detection, prediction, and classification of diabetes. The aim of this paper is to develop an approach that predicts the early stages of diabetes.

Undergraduate Student

Overview of Smart Home Cybersecurity Vulnerabilities

Primary Author: Faith Adkins, Computer Science

Co-Author(s)/Collaborators: Elizabeth Proctor; Katherine Spann; Kelsey Rainey

Advisor(s): Maanak Gupta

Everybody wants to keep their home safe, and to do that,

people want to entrust technology to assist with their protection. However, over the past few years there have been multiple exploits in smart home devices that have caused invasions to privacy, safety, and the security of sensitive information. With all of the different kinds of smart devices available, this research aims to break up everything into rooms of the house. Beginning with entering the house, this project displays many vulnerabilities found in security cameras and video doorbells. After entering the house, the navigation continues with the recent attacks and known vulnerabilities in smart appliances used in the kitchen. While navigating through the house, not only will the risks of the devices be assessed, but there will also be suggestions for protecting your own home from similar problems. After viewing the entire house layout of vulnerabilities, it is hoped that viewers will understand the possible weaknesses in devices that may be in their own homes. Also, viewers will be informed of recent cyber events concerning smart home devices.

Undergraduate Student

Joint Fault and Intrusion Detection For Industrial Internet of Things Sensing Environments

Primary Author: Ryan Brewer, Computer Science

Co-Author(s)/Collaborators: Arvin Sanchez; Yves Paultre

Advisor(s): Terry Guo

This on-going project aims to develop an Industrial Internet of Things (IIoT) testbed for undergraduate research and education. As Industry 4.0 becomes increasingly adopted in the mainstream factory environment, the burden of managing the physical sensing is placed upon the factory's network, presenting great information security risk as these IIoT devices are often significantly less secure than typical network nodes. With this research we provide a methodology for the implementation of insecure sensor devices in fault detection and isolation (FDI) while preserving the integrity of the environmental data in the event of network intrusion. This methodology will first determine if network intrusions influence data integrity through statistical analysis. Threshold and machine learning detection methods will be used to discover intruded datapoints and remove or remedy them before they enter the FDI systems. This research plans to show that defending against these intrusions is possible in the worst-case scenario, where only the telemetry data is available to detect from. Protecting the input into the FDI system is crucial. As reliance upon FDI systems, allowing them greater control over the factory environment, increases, the potential production risk due to intrusion increases in tandem. The current version of the testbed can retrieve single data telemetry from thermocouple and humidity sensors and display the output through a webpage and downloadable csv file.

Undergraduate Student

Predicting Functionality of Tanzanian Waterpoints

Primary Author: Brandon Cuskey, Computer Science

Co-Author(s)/Collaborators: Jacob Gable; William Lewis

Advisor(s): William Eberle

In modern Tanzania, many residents rely on local water pumps as their primary source of fresh water. As such, it is important that these pumps remain functional, and that any potential issues are identified and dealt with swiftly for the well-being of the Tanzanian people. Using data collected by the Tanzania Ministry of Water and organized with the Taarifa data management interface, our goal was to accurately predict the function status of waterpoints in Tanzania. We did this using machine learning algorithms to analyze the forty given features to create a model that can assess whether a pump is functional, nonfunctional, or functional but in need of repair. We completed this research as part of a competition hosted by DrivenData, and so we

assessed our results using DrivenData's prediction rate accuracy metric.

Undergraduate Student

AI in Cybersecurity

Primary Author: Nicholas Gamble, Computer Science

Co-Author(s)/Collaborators: Dalton Champion, Kenneth Vangemert, Yves Paultre

Advisor: Maanak Gupta

The intent of this project is to address the importance of artificial intelligence in cybersecurity by describing its various applications in both attacks and defense. As artificial intelligence finds a place in more and more aspects of life, we must be aware of its potential strengths and shortcomings, especially from a security standpoint. Artificial intelligence suffers from one crucial dependency above all else - it is only as effective as the data used to train it allows. This detail alone allows for two distinct approaches to undermine its integrity; namely, the use of methods or information that lie outside the bounds of that training data, or the manipulation of the training data itself to create vulnerabilities in the AI. Despite these shortcomings, however, AI technology presents a means of detecting and preventing intrusions that far outstrip human ability alone. A great deal of currently available antivirus software is itself a rudimentary implementation of AI, analyzing patterns and signatures in software and external data to prevent intrusion. Machine learning, in particular, is an incredibly versatile method for analyzing valid or invalid data and making appropriate judgements regarding system security.

Undergraduate Student

Virtual Assistants and Cyber Security Threats

Primary Author: Hossana Haileleul, Computer Science

Co-Author(s)/Collaborators: Riley Battilla; Daniel Holman

Advisor(s): Maanak Gupta

The use of technology in place of traditional tools continues to grow exponentially throughout the digital era and is an integral part of everyday life supported by the growing use of virtual assistants. A virtual assistant is an application programmed to understand natural language to independently complete user tasks. With the growing use of popular virtual assistants such as Siri, Alexa and Google Assistant, tasks such as writing/reading text messages and emails, setting up calendar reminders, and even making phone calls no longer need to be done by a person. Instead, all these can now be completed with the use of simple voice commands. Through this research, we will present the potential security threats and risks that may be concealed within these popular virtual assistants, and how to avoid them using various principles of cybersecurity security design.

Undergraduate Student

Security Concerns in the Blockchain

Primary Author: Ethan Hooper, Computer Science

Co-Author(s)/Collaborators: Josef Spradlin; Chance Tate; Seth Reagan

Advisor(s): Maanak Gupta

Our team is researching the security, privacy issues, and other aspects of the blockchain.We have conducted research pertaining to the broad security aspects that the Blockchain entails. In our poster, we plan to cover the basics of Blockchains, as well as a variety of vulnerabilities in them. The vulnerabilities we are covering are 51% attacks, phishing attacks, and endpoint vulnerabilities. We hope to provide some insight as to what attacks Blockchain users should be aware of and different ways to prevent and

reduce the impact of these attacks.

Undergraduate Student

The Cybersecurity Concerns of Smart Agricultural Vehicles

Primary Author: Brendan Jackson, Computer Science

Co-Author(s)/Collaborators: Conall Fisher; Jalen Stayton; Johnathan Rich

Advisor(s): Maanak Gupta

Smart Agricultural machinery has been advancing in the last decade and with it come more cybersecurity issues. If the heavy machinery used in farming were to be compromised, lives would be at risk for anyone tending to the farm or watching over the equipment. With smart agriculture having many assets in a system, the attack surface broadens significantly. The broad attack surface introduces many more vulnerabilities. Even the number of sensors and parts on specific vehicles is more than normal farming equipment, as to be completely autonomous, increasing the attack surface more. The integrity of the data sent to and from the machine is vital as one input could change the outcome of a crop yield. Not many solutions exist for the security of smart farm devices. However, implementing a combination of security principles may help smart agricultural machinery. There have been many farms that have compromised in the past. These show how important it is to protect these assets and how to implement such security principles. Using cyber threat intelligence will be vital in protecting our autonomous systems using known problems in other similar machinery.

Undergraduate Student

The State of Adversarial Machine Learning and Its Relevance to Cybersecurity

Primary Author: Kai Mackall, Computer Science

Co-Author(s)/Collaborators: Earl Pike; Chase Smith; Justice Thompson

Advisor(s): Maanak Gupta

Machine learning has been utilized for a number of applications in both the public and private sectors and is slated to become even more widely used in years to come. For this reason, the importance of security in this field cannot be understated. There are various ways to exploit and trick machine learning models into behaving in unexpected or unfavorable ways. Adversarial machine learning, the field of study of such methods, can be understood as a form of cyber threat intelligence, which describes the tools, knowledge, and experiences used to better understand cyber-related threats. We will further explain the security implications of adversarial machine learning, evaluate current progress in the field, and discuss a recent example of a related attack and its impact.

Undergraduate Student

Anomaly Detection using Convolutional Neural Networks in Wire Arc Manufacturing

Primary Author: Lukas Motykowski, Computer Science

Advisor(s): Doug Talbert

Wire arc additive manufacturing has grown in popularity because of its affordable cost, high deposition rate, and high material utilization. However, quality control is very important in this kind of manufacturing because the process stems from arc welding. Placing new welds on top of poor welds will not result in a quality product. Because of this, detecting the impurities is very important, and being able to identify the quality of each layer is very beneficial to the product. Real time quality control of these welds can be achieved by using machine learning techniques, and more specifically neural networks.

Convolutional neural networks can process images, and with the correct architecture, these images can be processed quickly and in real time.

Undergraduate Student

Vulnerabilities of Autonomous Vehicles: The Impact Self-driving Technology Has On Our Data and Safety

Primary Author: Sierra Osborne, Computer Science

Co-Author(s)/Collaborators: Sierra Stewart; Jonathan Rogers; Jayden Wright

Advisor(s): Maanak Gupta

Autonomous vehicles have seen a meteoric rise in recent years and will undoubtedly hold a significant place in our future. We, consumers, should know and understand the current vulnerabilities associated with autonomous cars and vehicles with new technologies. These companies acquire massive amounts of sensitive data and many consumers may be uniformed about what happens to their data and the dangers associated. As new technology is incorporated into any vehicle, the attack surface for the vehicle is widened, meaning consumers become more susceptible to attacks and information brokers. Researchers at the University of California, San Diego, "demonstrated hacks that could even activate the brakes of a car while the car was traveling," said News at Northeastern. However, most of the attacks like those in San Diego, have only been recorded in labs and other controlled spaces (livewire). As autonomous cars become more common, security vulnerabilities will increase exponentially. Our goal is to research these vulnerabilities and add information we find into a consumer-friendly model.

Undergraduate Student

IDS vs IPS

Primary Author: Joseph Page, Computer Science

Co-Author(s)/Collaborators: Rashed Alshareef; Robert Marascia; Thomas Marascia

Advisor(s): Maanak Gupta

We will be showing Intrusion Detection System (IDS) vs Intrusion Protection System (IPS). These two are a major tactic to use when protecting a network. We will be looking into strengths and weaknesses, the different kinds of IDS and IPS, the differences between both IDS and IPS, and the benefits that they offer.

Undergraduate Student

Abstract for Quantum Computing in Cybersecurity

Primary Author: Rachel Peters, Computer Science

Co-Author(s)/Collaborators: Zakariah Jaibat; Brendan Sullivan; Jonah Johnson

Advisor(s): Maanak Gupta

Background: Quantum computing is a type of computing that harnesses the power of quantum physics and a particle state called superposition. The power of quantum computers can render our current encryption methods useless and drastically change the cyber security environment. Uses of Quantum Computing: The use of quantum computers spans a variety of fields, including, but not limited to, processing larger datasets and examining failures in a system, advances in medical research, and space exploration. Vulnerabilities to Security: The rise of this new technology comes with its own set of vulnerabilities. Some of the vulnerabilities to be discussed are quicker decryption time and defense and offense in cyberspace. Defense: New defenses will need to be implemented to protect oneself from quantum computer attacks and protect a quantum computer from usurpation and misuse. Examples of defense include post quantum computing, quantum key distribution, quantum random number generators, and well-practiced principles of

security like fail-safe defaults.

Conclusion: Quantum computing is an excellent tool to have in furthering development in technology; however, with this development of new technology, new vulnerabilities will also come about that could crumble countries' infrastructure. Therefore, solutions to these problems will need to be discussed in advance to better prepare for the new age of quantum technology.

Undergraduate Student

Financial and Banking Sector Cyber Risks

Primary Author: Alec Szczechowicz, Computer Science

Co-Author(s)/Collaborators: Ethan Hammond; Dakota Sasser; Daimeyn Moss

Advisor(s): Maanak Gupta

Financial Institutions are the leaders in global cyber defense as the banking sector is very attuned to cyber risks. This project aims to identify what is currently being employed by financial institutions to defend their assets. As well as identify recent attacks, including attacks on financial institutions and crypto investors. Most methods are malware, spyware, novel ransomware, and email phishing tactics. Some people are also learning to abuse QR codes on cryptocurrency ATMs to trick people into sending them crypto. Also, given recent events, these attacks are only increasing. Vulnerabilities are exploited every day in the banking/online banking sector; these attacks range from stealing passwords to complete money theft. These attacks can cause damages anywhere from 1 million - 200 million dollars. The primary victims in these attacks are usually higher-profile customers due to their immense asset holdings. One of the significant ways hackers can access users' banking information is by abusing phishing attacks. This often happens from unnatural links on social media or email posing as the users preferred online payment software such as PayPal. A great way of preventing these types of attacks is to be more vigilant and aware of the layout within the web pages and emails. They often contain the business name misspelled in the URL so that the user believes it is accurate.

Undergraduate Student

Smart Agriculture

Primary Author: Sean Tyrer, Computer Science

Co-Author(s)/Collaborators: Trevor Trosin; Nathan Lamb; Keegan Farkas; Tommy Malyvanh

Advisor(s): Maanak Gupta

Our group and I will be submitting a poster on cybersecurity, within the sector of smart agriculture. This subject will range from a wide variety of things within smart agriculture, but our focus will primarily be on the internet of things (IoT). Our poster will display multiple images depicting what smart agriculture is today and how it is used throughout the agriculture industry. Our poster will also include multiple bullet points on various aspects of IoT , since we are focusing on the cybersecurity aspect. We will cover threats that the industry has previously faced and how the companies of today and tomorrow are trying to protect the industry, and how to best handle these attacks. We will also show all the technology related to IoT that is used within the industry and how the industry is expanding and how that relates to the risk of cyberattacks.

Our group will also cover any recent attacks on the industry such as the company affected and how they handled the attack and what they are doing to prevent attacks from happening again.We will also be using a trifold poster board to display our presentation. We are excited to be able to show people at the Creative and Inquiry Day the industry of smart agriculture and how cybersecurity relates to the field.

Undergraduate Student

Smart Wearable Devices

Primary Author: Cameron Williams, Interdisciplinary Studies

Co-Author(s)/Collaborators: Joshua Demeter; William Cooper; Ammanuel Getahun

Advisor(s): Maanak Gupta

The poster will explore various smart wearable devices and their vulnerabilities as well as the solutions to said vulnerabilities.

Undergraduate Student

Smart != Safe

Primary Author: William Wood, Computer Science

Co-Author(s)/Collaborators: Kieffer Ford; Billy Carico

Advisor(s): Maanak Gupta

Our presentation will be about Smart Cities, it will be about how they are currently progressing and what direction they are going, some of their vulnerabilities, and the recent attacks and impacts. With progressions in technology, of course the next step is to bring it to everyday life in cities. New York added 24/7 surveillance cameras and AI to protect public spaces after the events of 9/11. More advances include stoplights, remote infrastructure, monitoring systems, parking, and much more. With all of these great benefits to efficiency, there also come downsides. All of these components can be tampered with remotely and could have potentially devastating effects. There have already been cyber attacks on smart cities such as Knoxville, Las Vegas, and New Orleans. As security improves, so do attacks, so there is never a guarantee that a smart city means a safe city.

Department of Electrical and Computer Engineering

M.S.

Intelligent Control of Unmanned Aerial Vehicles in Areas of High Turbulence

Primary Author: Chijioke Ekechi, Electrical and Computer Engineering M.S.

Advisor(s): Tarek Elfouly

Unmanned aerial vehicles are gaining immense popularity and have found applications in delivery services, monitoring tasks and in military operations. There is one question we have yet to answer, which is, how well can a drone perform in an area with extreme turbulence? This question will be addressed in this study by comparing the performance of the drone under harsh weather conditions, with regular control mechanisms, to an intelligent control or learning technique. This article will demonstrate how Reinforcement Learning can be used to train a quadcopter to perform a certain task in turbulent areas while maintaining stability. A trained quadcopter will be assigned to a mission and will be controlled from the start point to the desired destination, maintaining stability, utilizing minimal energy, and taking the shortest time to complete without having to communicate with the drone's control system explicitly or directly. Specifically, we will be working with the Proximal Policy Optimization Reinforcement Learning Algorithm, which seeks out an optimal policy that ensures the maximum rewards for an agent or a group of agents participating in interactions with the environment. It belongs to a class of RL algorithms called Policy Gradient Algorithms, which aim to obtain the most optimal policy, rather than the most optimal state or state-action value function. We will examine the behavior of the agent when the Dryden Turbulence Model is introduced.

M.S.

An Efficient Method of Analyzing Conservative Reversible Logic Gates and Circuits

Primary Author: Tyler McCormick, Electrical and Computer Engineering

Co-Author(s)/Collaborators: J.W. Bruce, Tennessee Technological University

Advisor(s): J.W. Bruce

Computers, which have become a ubiquitous staple of modern society, consume nearly 10% of all the energy produced worldwide. While computing implementation technology has been made more energy efficient over the years, the energy required to operate a gate logically has become an increasingly large proportion of the total energy required. A systematic improvement of this power use would result in significant power savings, which would grow even more appreciable as overall efficiency improves. One method for achieving these power savings would be the use of conservative reversible logic (CRL) gates for system design. However, to date, only a few designs using these types of gates have been developed. One of the reasons for this sporadic development is due to the lack of an efficient method of analyzing CRL gates and circuits. This work describes an accurate and efficient method for analyzing the outputs of CRL gates and circuits of any size using a modified Karnaugh Map (K-Map). The full analysis of several CRL gates and circuits are presented, along with an efficiency comparison to conventional analysis methods.

M.S.

TTS Wireless Power Transmission

Primary Author: Brandon Nieman, Electrical and

Computer Engineering M.S.

Advisor(s): Charles VanNeste

Increasing the spatial and temporal density of data using networked sensors, known as the Internet of Things (IoT), can lead to enhanced productivity and cost savings. In industries with large outdoor expanses such as farming, oil and gas, or defense, large regions of unelectrified land could have significant monitoring benefits if instrumented with a high density of IoT devices. The major limitation of expanding IoT networks in such applications stems from the challenge of delivering power to each sensing device. Batteries are the primary power method of IoT networks and become impractical as the number of elements per area is increased. The only long-range wireless power techniques currently available rely on far-field, line-of-sight technologies or point-to-point transfer utilizing drones. This work presents a different approach where conduction currents through soil are utilized for the wireless powering of sensor networks within an initial 2-acre (8000 m^2) area. The technique is not line-of-sight, powers all devices simultaneously through near-field mechanics, and is minimally invasive to the working environment.

M.S.

AI Based Optimization of Solid State Transformer Core for Modern Electric Vehicles Using Multi-Objective Genetic Algorithm

Primary Author: Abiodun Olatunji, Electrical and Computer Engineering M.S.

Co-Author(s)/Collaborators: Indranil Bhattacharya; Webster Adepoju

Advisor(s): Indranil Bhattacharya

Solid-state transformers are increasingly becoming a desirable alternative to traditional low frequency transformers due to their compact size and high efficiency, particularly in the field of Electric Vehicles (EV), which has seen rapid growth in recent years. This research offers a multi-objective AI-based high-frequency transformer (HFT) design optimization for solid-state transformer (SST) applications. As the key component of the SST, the optimization of the HFT design parameters is crucial for achieving high efficiency and power density, independent of its topology. The HFT is designed using a multi-objective Non-dominated Sorting optimization technique that reduces core volume (maximizing power density), total transformer losses, and overall cost from the set multiple Pareto-optimal solutions (POS). An 750kHz, 10kW HFT of different high permeability core materials is explored as a case study and the POS are presented. The findings show how the various design variables affect the goal functions. The results further show that the size, efficiency, and cost of the HFT may be efficiently optimized by carefully selecting design variables using the suggested method. A large number of the Pareto-Optimal solutions demonstrate that in the HFT design for SST applications, an efficiency of above 97% can be attained.

Ph.D.

A New Histogram-based Visualization Tool for Analyzing Anomaly Detection Algorithm Performance

Primary Author: Emmanuel Aboah Boateng, Engineering Ph.D.

Co-Author(s)/Collaborators: J.W. Bruce

Advisor(s): J.W. Bruce

Performance visualization of anomaly detection algorithms is an essential aspect of anomaly and intrusion detection systems. It allows analysts to highlight trends and outliers in anomaly detection models results to gain intuitive understanding of detection models. This work presents a new way of visualizing anomaly detection algorithm

results using a histogram. The approach presented in this work provides a better understanding of detection algorithms performance by revealing the exact proportions of true positives, true negatives, false positives, and false negatives of detection algorithms. The histogram-based approach was used to visualize the prediction confidence and performances of anomaly detection algorithms on multiple datasets to provide insights into the strengths and weaknesses of these algorithms on different aspects of the datasets. The proposed approach is compared with previous histogram-based visualization methods that rely on only positive and negative anomaly scores. The results show that the proposed method provides a better meaning of detection algorithms performances. Finally, this work presents further results that show how the proposed method can be applied to performance visualization and analysis of supervised machine learning techniques involving binary classification of imbalanced datasets.

Ph.D.

Modeling and Analysis of Equivalent Circuit of Metamaterial-based Wireless Power Transfer System

Primary Author: Webster Adepoju, Engineering Ph.D.

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Indranil Bhattacharya

Advisor(s): Indranil Bhattacharya

In this study, an equivalent circuit model is presented to emulate the behavior of a metamaterial-based wireless power transfer system. For this purpose, the electromagnetic field simulation of the proposed system is conducted in ANSYS high-frequency structure simulator for medium parameter extraction. In addition, a numerical analysis of the proposed structure is explored to evaluate its transfer characteristics. The power transfer efficiency of the proposed structure is represented by the transmission scattering parameter. While some methods, including interference theory and effective medium theory have been exploited to explain the physics mechanism of MM-based WPT systems, some of the reactive parameters and the basic physical interpretation have not been clearly expounded. In contrast to existing theoretical model, the proposed approach focuses on the effect of the system parameters and transfer coils on the system transfer characteristics and its effectiveness in analyzing complex circuit. Numerical solution of the system transfer characteristics, including the scattering parameter and power transfer efficiency is conducted in Matlab. The calculation results based on numerical estimation validates the full wave electromagnetic simulation results, effectively verifying the accuracy of the analytical model.

Ph.D.

Mitigation of Jahn-Teller Effect in P2 type Sodium Iron Manganese Oxide Cathode via Ti and V Doping

Primary Author: Trapa Banik, Engineering Ph.D.

Co-Author(s)/Collaborators: Indranil Bhattacharya

Advisor(s): Indranil Bhattacharya

Sodium-ion battery (SIB) is regarded to possess enormous potential to serve as a drop-in replacement to lithium-ion battery (LIB)technology in the ever-expanding energy storage market due to its attractive combination of homogeneous profusion in the earth and identical intercalation chemistry to LIB. It is critical to determine a suitable cathode to facilitate facile Na-ion transport as cathode is the key factor affecting cycle life, energy density as well as safety. Among all the prevailing SIB cathode materials, the P2 type Na(2/3)Fe(1/2)Mn(1/2) O2 (NFM) has attracted broad attention as a promising cathode candidate due to the abundance of Fe and Mn

with high redox couple of Fe3+/Fe4+ and Mn3+/ Mn4+. Despite all these merits, NFM suffers from structural instability arising from the destructive Jahn-Teller (JT) distortion effect of Mn3+/ Mn4+ during charging and Fe4+/ Fe3+ during discharging. Despite numerous strategies proposed by researchers to address the JT effect, this study investigates the elemental doping process. In this research, a tiny fraction of two electrochemically inactive elements, Ti and V are incorporated in Mn-rich cathode that mitigated the JT effect substantially and ameliorated the stability during cycling. A systematic study is executed for Na(2/3)Fe(1/2)Mn(1/2)O2 with various stoichiometry of combined Ti and V fraction and the results from material and electrochemical analysis validate the doping has alleviated the JT effect to a significant extent.

Ph.D.

Highly Modular Robotic Connections using Quasi-Wireless Capacitive Power Transfer for Aerospace Applications

Primary Author: Tyler Marcrum, Engineering Ph.D.

Co-Author(s)/Collaborators: Charles CanNeste, Tennessee Technological University; Matthew Pearce, Tennessee Technological University

Advisor(s): Charles VanNeste

Switching end-effectors, quickly replacing a damaged linkage, or changing the kinematics of a robotic appendage could have transformative impacts in the aerospace industry. However, designing a robotic system capable of such rapid modularity is extremely challenging with contemporary multi-wire harnesses and connectors. This work presents a first-of-its-kind system where a robotic appendage is fabricated without any interconnected wires. Instead, power is transferred through the chassis using a quasi-wireless capacitive return path. The robotic system offers a new design path that requires no wiring between joints and allows re-configurable kinematics with rapidly replaceable end effectors/parts. A working prototype is demonstrated, and the wireless power transfer parameters are analyzed and discussed.

Ph.D.

Analysis and Design of Bidirectional Wireless Power Transfer Systems Using Matlab/Simulink

Primary Author: Ebrahim Nasr Esfahani, Engineering Ph.D.

Advisor(s): Indranil Bhattacharya

The application of wireless power transfer (WPT) technology has gained global attention in electric transportation due to its outstanding advantages. This article presents the design of a 3kW bidirectional based on the Dual active bridge topology with LLC tank. Sensitivity analyses of the WPT resonant tank were conducted to verify the optimal operating region under the load and coupling factor variation. Matlab/Simulink results demonstrate the performance of the bidirectional systems with the efficiency of 90%.

Undergraduate Student

Minimal CRL Gate Designs for Logical Operations with Two and Three Inputs

Primary Author: Weston Beebe, Computer Engineering

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

Co-Author(s)/Collaborators: J.W. Bruce and David Goldhirsch

Advisor(s): J.W. Bruce

Conservative and reversible logic gates are widely known

to be compatible with and exhibit great efficiency on revolutionary computing paradigms such as low power, optical, and quantum computing. The fundamental conservative reversible logic (CRL) gate is the Fredkin gate. Functionally complete, Fredkin gates can implement any digital logic function, including those commonly used in classical computing. While some researchers have used the Fredkin gate to build assorted logic functions, this work describes a systematic study to discover efficient implementations of all two-input and the most common three-input logic functions using both the Fredkin gate and CRL gates of size 4. The results of this study have been observed to have useful results in implementing more than one single primitive logic function in their outputs for specific CRL gate implementations. The garbage outputs that are observed to be useful primitive logic functions will allow for minimized gate counts in the design of a system.

Undergraduate Student

Towards Automated Machine Learning Detection of Academic Dishonesty in Computer-Based Testing

Primary Author: Parth Patel, Computer Engineering

Co-Author(s)/Collaborators: J.W. Bruce, Tennessee Technological University
Advisor(s): J.W. Bruce

The global pandemic forced a rapid shift of learning environments to an online and remote modality. In a computer-based testing environment, ensuring academic integrity is difficult without resorting to technology that is intrusive to student privacy. During online examinations, students have many opportunities and resources to act dishonestly. However, the computer-based testing environment also provides data about the examination process that can be collected which is not possible in face-to-face settings. Utilizing features extracted from computer-based testing logs, a machine learning model was implemented to determine if students completed the exam honestly or not. The model was validated with high recall or low false negatives. Implementing this model into online examinations would allow for suspected academic dishonesty to be automatically flagged for further review by the instructor. Results indicate it is possible for the model to detect dishonest conduct, including unauthorized collaboration and utilization of external resources such as exam assistance services.

Department of Manufacturing and Engineering Technology

M.S.

Optimizing Lattice Infill Structures to Reduce Mass & Power Consumption for Popular 3D Printing Technologies

Primary Author: Mohammad Alshaikh Ali, Mechanical Engineering

Advisor(s): Ismail Fidan

With Additive Manufacturing (AM) being heavily utilized in many industries and applications, several studies are done to evaluate different process parameters of the different AM methods. This work investigates the use of lattice infill structures to reduce mass and power consumption in two of the most common AM methods, Stereolithography (SLA) and Fused Filament Fabrication (FFF). Previous studies done in this lab explored the power consumption and surface finish of these different technologies. The results of these studies lead to SLA being the superior AM method when it comes to power consumption and surface finish, while FFF takes much less time. With prior experimental results, optimum printing parameters are used to compare to lattice infill structures. Three different test specimens are used to perform this study; a bolt, a steering knuckle, and a knee joint. Shelling the objects and creating lattice infill structures is done using ANSYS SpaceClaim. For the two different AM methods, build time, mass, power consumption, and surface finish results are documented. Results indicate SLA responds exceptionally well with lattice infill structures. For lattice infill in FFF, advanced printing parameters are altered to optimize the use of such infill.

M.S.

Knowledge Base Development for the Iron-PLA Composite Filaments in Additive Manufacturing

Primary Author: Ranger Buchanan, Mechanical Engineering

Co-Author(s)/Collaborators: Joji Jeevan Kumar Dasari; Webster Adepoju; Indranil Bhattacharya, Electrical and Computer Engineering; Ismail Fidan, Manufacturing and Engineering Technology

Advisor(s): Ismail Fidan

Additive Manufacturing (AM) is the process of manufacturing where instead of cutting away from material to produce a desired part, as in Traditional Manufacturing (TM), one constructively adds material to create a required design. The benefits of AM allow for some designs that are impossible to be manufactured with TM methods. One of the most common AM process is Fused Filament Fabrication (FFF) 3D printing, which utilizes layers of extruded materials to manufacture objects. While the most common materials used in 3D printing are plastics, some other materials, including composite materials, can be used.

The power consumption of any electronics is related to run time, though power consumption is also influenced by how much energy the electronics need to operate. By reducing the run time of the 3D printer, one is able to reduce the energy consumption of that 3D printer. 3D printers have methods of reducing run time by increasing layer height, decreasing infill density, or increasing print speed, but all of these factors will affect the quality of the print. This research intends to show the ability to manufacture Iron-PLA composites and analyze the mechanical and electrical properties in addition to the energy consumption of the resulting prints based upon print parameters.

Ph.D.

Investigation of the Thermal Properties of Various Short Carbon Fiber Reinforced Polymers in Fused Filament Fabrication Process

Primary Author: Orkhan Huseynov, Engineering Ph.D.

Co-Author(s)/Collaborators: Ismail Fidan

Advisor(s): Ismail Fidan

A considerable amount of literature has been published on the thermal properties of the additively manufactured polymers. However, there has been no study focused on the effect of the reinforced fiber in various matrix materials to measure the thermal properties of such additively manufactured parts.

The aim of this research is to explore the influence of various matrix materials, numerically and experimentally, on the thermal conductivity, thermal strain and degree of healing in matrix materials of PETG, PC/PBT, ABS and Nylon. The anisotropic behavior of the composites is also evaluated by changing the build direction. This work also attempts to simulate the temperature evolution in the printed materials. In order to do this, 3D implicit finite difference method is constructed using element activation method. The results obtained are important in reporting the relationship between short carbon fibers and different polymers.

Our research group has reported valuable findings on continuous fiber reinforced additive manufacturing processes. The current findings of our group for the thermal properties of short carbon fiber reinforced filaments performed in this study will be benchmarked to differentiate the pros and cons of both technologies.

Ph.D.

Fatigue Analysis of Carbon Fibre Reinforced Composite Components Manufactured by Fused Filament Fabrication

Primary Author: Mithila Rajeshirke, Engineering Ph.D.

Co-Author(s)/Collaborators: Ismail Fidan

Advisor(s): Ismail Fidan

The development of fiber composites in recent years has been remarkably strong, owing to their high performance and durability. The fatigue behavior of components is an important knowledge, as cyclic loading is a common feature of most engineering applications. The scope of this paper is to present the fatigue properties of carbon fiber-reinforcing Polyethylene terephthalate glycol (CF-PETG) components manufactured by FFF with a focus on different printing orientation. Simplify 3D and stacker S2 are used to slice and to manufacture the components respectively. The printing orientation and direction used are XY-00, XY 450, XY 900 and YZ 900. Fatigue testing is carried on 70% of Ultimate Tensile Strength (UTS). Analysis of Variance (ANOVA) is used to analyze the data obtained from the fatigue test.

Ph.D.

Investigation of Optimum Quality Parameters of Low-cost Metal Material Extrusion using Machine Learning and Response Surface Methodology

Primary Author: Zhicheng Zhang, Engineering Ph.D.

Advisor(s): Ismail Fidan

Additive manufacturing (AM) is a widely used layer-by-layer manufacturing process. However, the good quality production of additively manufactured parts is limited

by the use of different materials, machines and process parameters. Material Extrusion (ME) is one of the most widely used AM technologies. Thus, it is adopted in this research. Low-cost Metal Material Extrusion (LCMME) is a new AM technology used to fabricate metal parts using sintering metal infused filament material. Since the filaments used in LCMME are relatively new, there is a need to investigate the most suitable process parameters of the LCMME process for real-world applications. Each step of the process such as 3D printing of the samples and the sintering will affect the quality of final part significantly. By using Machine Learning and Response Surface Methodology (RSM), a comprehensive quality analysis of the Bronze samples fabricated by the LCMME process is developed in this research. RSM can assist researchers in sophisticated pre-manufacturing planning and product quality assessment and control. The findings of this study can help researchers and engineers to optimize the process parameters to obtain high quality metal parts fabricated by LCMME process.

Ph.D.

Tensile and Fatigue Analysis of Functionally Graded Materials produced by Fused Filament Fabrication

Primary Author: Suhas Alkunte, Engineering Ph.D.

Co-Author(s)/Collaborators: Seymur Hasanov; Ismail Fidan

Advisor(s): Ismail Fidan

The aim of this research study is the design, fabrication, and mechanical characterization of functionally graded composite materials using the fused filament fabrication (FFF) process. Chopped carbon fibre reinforced Polyethylene Terephthalate Glycol (CCF-PETG) and CCF-Nylon materials are fabricated by the Zmorph Fab desktop machine. The digital design of gradient structures is achieved by the voxelization process of the computer aided design (CAD) files. One of the main drawbacks of FFF parts is weak in shear strength that is due to the orientation of the raster plane, so FGM is one of the ways to enhance the mechanical properties of the material. Tensile behaviour of FGM parts fabricated in various processing parameters such as print directions, infill orientations, layer heights, etc. Tensileâ€“tensile fatigue tests with a stress ratio of 0.1 were performed on each specimen at 90, 80, 70, and 60% of UTS. This knowledge-based study will be conducted with the hypothesis that the tensile strength of CF PETG and CF Nylon materials are less than that of functionally graded CF PETG and CF Nylon materials. The specimen's longest fatigue life was found at a stress level of 60%. This study presents a first-of-its-kind experimental examination of FGM tensile and fatigue characteristics.

Department of Mechanical Engineering

M.S.

A Method to Generate 3D Patient-Specific Total Knee Arthroplasty Tibia Models

Primary Author: Andrew Gothard, Mechanical Engineering M.S.

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Steven Anton

Geometric information of a patient's anatomy is vital in preoperative planning for orthopedic surgeries. At present, many physicians rely on analysis of 2D scans, such as radiographs, in order to visualize a patient's geometry. Research is being done to develop patient-specific 3D bone geometries to aid in preoperative planning. While 3D models have been developed for several parts of the human anatomy, there is still a great need for cost-effective ways to create personalized total knee arthroplasty (TKA) models. Currently, methods for creating patient-specific knee geometries typically only consider patients without TKA implants, rely on expensive medical imaging through layered CT scans, and/or require a large database of 3D models. This work presents a novel, semi-automated process to create patient-specific 3D tibia geometry for TKA patients using pairs of standard bi-planar radiographs. The method presented involves two stages. In the first stage, the geometric bone contours are extracted from two bi-planar radiographs of the tibia by using gradient thresholding and Canny edge detection. The second stage aligns the two extracted tibia contours with a generic 3D tibia model from the 6th SimTK Grand Challenge Dataset and then modifies the generic 3D model to match the radiographic contours using full-ellipsoidal scaling. This method will be evaluated by calculating the correlation between the generated contours from the 3D model and the original radiographic contours.

M.S.

Investigation into Piezoelectric Bone Cement for Total Knee Replacements

Primary Author: Brandon Hines, Mechanical Engineering M.S.

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

Advisor(s): Steven Anton

Total knee arthroplasty (TKA) is one of the most common orthopedic surgeries performed in the United States. Though most cases of TKA are successful, some cases experience post procedure failure. Smart implant technology seeks to aid the medical community in identifying failure that may require a revision surgery. Previous work has explored sensing applications aimed at identifying failure in simulated total knee replacements (TKR) by bonding lead zirconate titanate (PZT) wafers to a tibial tray implanted in a simulated knee structure. Though this application demonstrated success identifying failure in the simulated TKR system, an obstacle that must be overcome is the use of lead in the biomedical system. A proposed solution to this problem is to develop a specialized sensor with the application of joint replacements in mind. This study explores the idea of developing a specialized piezoelectric sensor using bone cement and barium titanate as the primary materials. The specialized sensors are generated by mixing barium titanate powder with bone cement, then forming the mixture into wafers for curing. The wafers are then subjected to a poling process to give the sensors their piezoelectric properties. A performance comparison is presented between the proposed sensors and previously studied PZT sensors. The goal is to demonstrate the efficacy of the specialized sensors at collecting useful information from a system by comparing them to more widely used piezoelectric sensors.

M.S.

Investigation of Mounting Techniques for Concrete Floor-Mounted Accelerometers used in Smart Buildings

Primary Author: Jacob Hott, Mechanical Engineering M.S.

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

Advisor(s): Steven Anton

In smart building infrastructure the mounting of measurement devices must be carefully determined in order to obtain meaningful records of the dynamics within a building. This is crucial in safety critical applications such as footstep localization, fall detection, and gunshot detection since high frequencies could possess useful information. Currently, it is common practice in structural health monitoring of building infrastructure for sensors to be mounted either temporarily on the surface of a floor, or permanently on the underside of the structural steel floor joist. Using either of these methods causes limitations in either the permanence of the setup or in the spacing of sensors. This paper explores a novel accelerometer mounting method to overcome these limitations by mounting accelerometers on the underside of a concrete floor with an anchored steel plate. This method will be evaluated through experimental testing and analysis on a developed floor section mockup which mimics the floor structure currently being constructed in Tennessee Technological University's new engineering building. Testing is carried out by using an impact hammer on the concrete surface of the floor section while measuring the response from accelerometers mounted at various locations. The frequency response of the floor tray-mounted accelerometer is assessed and compared to that of conventional floor-mounted and joist-mounted accelerometers installed on the same mockup.

M.S.

Electrical Storage and Power Generation for Commercial Electric Aircraft

Primary Author: Trevor Kramer, Mechanical Engineering M.S.

Co-Author(s)/Collaborators: Rory Roberts; Jeff Webster

Advisor(s): Rory Roberts

A hybrid Solid Oxide Fuel Cell (SOFC) gas turbine cycle is being suggested to provide sufficient power generation on an electric aircraft. A Boeing 737 style commercial aircraft is estimated to require ~28 MW of electrical power for stable flight and operation. Electric ducted fans will serve as the propulsion for the aircraft with bio-liquefied natural gas (BIO LNG) serving as the fuel and coolant for the thermal management system. A Solid Oxide Fuel Cell Combustor (SOFCC) will take the place of the combustor in a traditional power generating Brayton Cycle. The tubular SOFC stack will operate in a counter-flow configuration allowing the anode off gas to combust with the compressed air and preheat the cathode air in the SOFC stack. The power density and efficiency are tracked when the cycle is modified to include post combustion of SOFCC exhaust gas before the turbine inlet. A Turbo-generator - Lithium-Ion Battery Pack hybrid was also examined. This concept is more feasible for smaller, regional electric aircraft with a flight distance of around 300 miles. In this analysis, this concept was scaled up to compare with the performance of the SOFCC-GT concept.

M.S.

Floor-Vibration-Based Fall Detection: A Literature Study

Primary Author: Al-Barkat Mehedi, Mechanical

Engineering M.S.

Advisor(s): Sally Pardue

Among elderly people, one of the leading causes of mortality and morbidity is an undetected human fall event. The consequences of a falling incident related to health safety are primarily determined by the speed with which the elderly person is rescued. The ability to identify falls accurately and quickly significantly enhances the likelihood of improved outcomes following the incident with the potential to lower the cost of subsequent healthcare. Research in this field not only forms detection of human falls but also of falling objects. Manufacturing facilities, fire and rescue departments, as well as the healthcare industry routinely face the challenge of detecting and responding to a fall incident accurately and rapidly. This literature study explores current published research and summarizes ongoing and completed work in the field of floor-vibration-based fall detection both in humans and objects. For fall detection, numerous sensing technologies have been used, both wired and wireless depending on the application, including smart homes, healthcare, search-and-rescue, and security. Furthermore, the broad application potential of floor-vibration -based sensing systems is discussed.

Keywords: Fall detection, Floor vibration, Human activity, Sensor.

M.S.

Automated Weld Path Generation Using Random Sample Consensus and Iterative Closest Point Workpiece Localization

Primary Author: Robert Shelton, Mechanical Engineering M.S.

Co-Author(s)/Collaborators: Tristan Hill

Advisor(s): Stephen Canfield

In traditional automated manufacturing environments, tasks such a welding are achieved through execution of pre-programmed tool motions, requiring the location and orientation of the workpiece to be fixed and known. This lack of spatial information is often treated through positioning of the workpiece with respect to the robot arm using jigs or fixtures which are costly in initial setup and not easily modified. Further, the resulting toolpath associated with a desired task is typically defined through manual teaching resulting in a path appropriate for an individual job. For this reason, jobs of small to medium enterprises requiring variation in part geometry or arrangement are not commonly automated. This work presents a method for automated weld path generation for a 6DOF co-bot arm using random sample consensus and iterative closest point workpiece localization from LiDAR pointclouds. Scans from a low cost 2D LiDAR mounted to the co-bot arm generate 3D pointclouds of the workspace scene with the Robot Operating System (ROS). The Point Cloud Library is used to compare the generated pointcloud with a CAD model to produce a rigid transformation to localize the workpiece. The estimated pose of the workpiece with respect to a fixed frame is used offline to generate a weld path as series of tool poses. Two example welding processes are investigated and a physical implementation of the method is demonstrated using a 2D LiDAR mounted to a 6DOF co-bot carrying a MIG welding torch.

Ph.D.

Temperature Compensation for Electromechanical Impedance Signatures With Data-Driven Modeling

Primary Author: James Femi-Oyetoro, Engineering Ph.D.

Co-Author(s)/Collaborators: Mohammad I. Albakri

Advisor(s): Mohammad Albakri

Impedance-based structural health monitoring (SHM) is recognized as a non-intrusive, highly sensitive, and model-independent SHM solution that is readily applicable to complex structures. This SHM method relies on analyzing the electromechanical impedance (EMI) signature of the structure under test over the time span of its operation. Changes in the EMI signature, compared to a baseline measured at the healthy state of the structure, often indicate damage. This method has successfully been applied to assess the integrity of numerous civil, aerospace, and mechanical components and structures. However, EMI sensitivity to environmental conditions, the temperature, in particular, has been an ongoing challenge facing the wide adoption of this method. Temperature-induced variation in EMI signatures can be misinterpreted as damage, leading to false positives, or may overshadow the effects of incipient damage in the structure.

In this work, we investigate the feasibility of using data-driven modeling for temperature compensation of EMI signature is presented. Data-driven dynamic models are first developed by fitting EMI signatures measured at various temperatures using the Vector Fitting algorithm. Once these models are developed, the dependence of model parameters on temperature is established. The capabilities of this temperature compensation method are demonstrated on aluminum samples, where EMI signatures are measured at various temperatures and over a broad frequency range.

Ph.D.

Predicting Unknown Upstream Events using Convolutional Neural Network

Primary Author: Reza Nouri, Engineering Ph.D.

Advisor(s): Ahmad Vaselbehagh

Convolutional Neural Network (CNN) is a tool that one can use to deduce information about unknown upstream events in fluid dynamics. We applied an existing CNN, GoogLeNet, to predict the shape of upstream obstacles disturbing the flow using the information collected downstream. Flow over six two-dimensional geometries was simulated to collect data needed for training the model. The geometries included a triangle, square, pentagon, hexagon, heptagon, and octagon. The input of the CNN model was the absolute values of the continuous wavelet transform (CWT) of velocity signals recorded in near, middle, and far wake regions downstream of the studied cases. CWT transforms velocity signals into functions of time and frequency called scalograms. These scalograms were then used to train the model. This study used 420 signals (either in the near, middle, or far wake region). Then, ten random signals that did not participate in the training (hence were unknown to the trained model) were employed to evaluate the model's performance. The model successfully predicted the shape of each geometry in each unknown case.

Ph.D.

Optimization of Functionally Graded Electrodes for Solid Oxide Fuel Cells

Primary Author: Aaron Bain, Engineering Ph.D.

Advisor(s): Rory Roberts

Functionally graded electrodes have been used in solid oxide fuel cell research in recent years in an effort to improve the cell performance by altering the microstructure including porosity, particle size, and composition of electronic and ionic conductors near the triple phase boundary region. The enhancements obtained by using functional grading include lengthening the effective triple phase boundary, expanding the electrochemical surface area, and improving mass flow of the fuel cell reactants. This results in a higher amount of power output per unit surface area. It has also been found

that applying functional gradation can help to decrease operating temperature and pressure. By reducing the operating temperature or pressure, many engineering constraints involved in the system design, such as heat transfer, seal design, and in-line fuel and oxidizer heaters can be alleviated. Furthermore, as the cell temperature is reduced, entropy generation is decreased. An effective medium model has been formulated, accounting for ionic and electronic conduction and gas diffusion in composite electrodes. The electrochemical relations such as the Butler-Volmer equation are represented in a boundary value problem and nonlinear optimization of electrode parameters is sought using the BFGS algorithm. Optimal gradation profiles are derived as a function of particle size, ratio of conductivities, and desired operating conditions and scored based on their reduction of cell overpotentials.

Undergraduate Student

Analyzing the Mechanical Properties along the Length of Human Achilles Tendon

Primary Author: Miguel Fuentes Garcia, Mechanical Engineering

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

Advisor(s): Steven Anton

The literature shows there is no valid procedure to measure the tensile properties in different regions along the length of human tendons. The slippery surfaces and non-homogeneous properties of tendons reduce the probability of success when using traditional methods. So, there is a need to implement an experimental technique that ensures accurate measurement of the mechanical properties of human tissue. The development of new technologies allows us to face problems with new approaches. Computer vision is a trending topic in the development of new technology, one of its branches is digital image correlation (DIC). DIC is a non-contact technique used for tracking pixels along a group of sequential images, and, when combined with tensile testing, can be used to track sample deformation and strain at discrete points in space. This work investigates mechanical testing of Achilles tendons using digital image correlation (DIC) and custom-designed 3D printed clamps. The advantage of DIC is that it analyzes the deformation of the tendon throughout the complete sample, allowing us to quantify the mechanical properties in different regions within the tendon. These results can be used in the future to aid in the design and material selection of prosthetic tendons for people suffering from injury or disease.

Undergraduate Student

Vibration Analysis of a Concrete Slab Floor Using Piezoelectric Accelerometers

Primary Author: Warren Sims, Mechanical Engineering

Advisor(s): Sally Pardue

Analyzing and interpreting floor vibration responses experienced daily throughout a building could serve as a major asset by monitoring the well-being of the inhabitants, predicting the number of occupants, and acting as an additional unintrusive security measure. This preliminary study used piezoelectric accelerometers in conjunction with oscilloscopes to observe the excitation and response of a classroom concrete floor in a 1960's era building. Various known and unknown impact events were evaluated through a series of tests and configurations including excitation events such mass drops, footfalls, and strikes from an instrumented hammer. The acquired data was further analyzed using MATLAB and Microsoft Excel. Results indicate that it is possible to approximate the location and extent of impact; however, the rate of degradation of the response monitored is highly subjective to the extent and location of the initial impact and the location of the sensors relative to the supporting structures of the room. The initial results provide evidence that meaningful vibrational

analysis of floor motion due to impacts is attainable. Further analysis and testing are required to refine and interpret these results to serve as background for future studies, specifically in the new engineering building. Simultaneous data acquisition with more elaborate sensor configurations as well as computational simulations for floor responses could serve as major additions to this study going forward.

College of Fine Arts

School of Music

Undergraduate Student

Contrabassoon Restoration

Primary Author: Jacob Starker, Music

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

Advisor(s): Jeff Womack

The Bassoon Studio in the School of Music at Tech uses a contrabassoon as a significant part of its curriculum. Not all universities in Tennessee own a contrabassoon and the fact that Tennessee Tech owns and studies on this instrument gives the students at Tech a decided advantage over their peers from other institutions.

Tennessee Tech's contrabassoon was built in 1965 and, over time, had fallen into disrepair and suffered an unfortunate fall. Consequently, the condition of the instrument did not allow students to use it to its (or their) fullest potential. We are fortunate that a world-renowned bassoon technician lives 40 minutes away in Alexandria, Tennessee. This individual offered to teach me, and my professor, the skills needed to restore the instrument to its best possible condition. A list of supplies/tools was compiled and a URECA grant application was submitted and awarded. The grant award covered the entire cost of the materials needed, and the work was completed over a 23-day period during the summer of 2021.

Techniques involved included completely stripping/disassembling the instrument, repairing broken pieces, sealing the wood, reassembling, and replacing and sealing pads so that the instrument was airtight. Afterwards, the instrument was extensively tested and tuned.

The project was very successful and the instrument was featured in a performance with the Bryan Symphony Orchestra in a Fall 2021 concert by the student that performed the restoration.

College of Interdisciplinary Studies

School of Environmental Studies

Undergraduate Student

GIS Applications for Bridgestone Nature Reserve

Primary Author: Macklin Allan, Environmental and Sustainability Studies

Co-Author(s)/Collaborators: Christopher Ingham; Devin Hudgins

Advisor(s): Steven Sharp

Geographic Information Systems (GIS) have shown to be valuable for The Nature Conservancy's Bridgestone Reserve's solar energy efforts and their outreach projects for nearby landowners. Initially, GIS analysis for light detection and ranging was utilized for determining the recommended site placement for solar panels within the Conservancy's property. This approach in calculating the most ideal site placement for solar panels is a cost-effective method for ensuring the best possible generation of energy. Based on the tools that were executed in the GIS platform relating to Digital Elevation Model and Solar Radiation, the recommendation for the placement of the panels is to be on the ground rather than rooftop. In addition, GIS used data that was supplied in an ArcGIS spreadsheet and cross checked with data from the State of Tennessee's Real Estate Assessment Database. This contributed to the team's project of identifying eligible private forest landowners for outreach. This was done by spatially joining two layers and running multiple queries within those two layers. The original database showed a total of 35,987 addresses of privately owned small, forested lands in the Upper Cumberland. After putting in parameters relating to acreage and percentage of trees, the number of workshop appropriate landowners was reduced to less than 400.

Undergraduate Student

The Feasibility of Wind Power for Bridgestone Nature Reserve at Chestnut Mountain

Primary Author: Isabella Kinsey, Environmental and Sustainability Studies

Co-Author(s)/Collaborators: Grace Cooke; Evan Langley; Spencer Brantley

Advisor(s): Steven Sharp

This project involved researching the feasibility of bringing wind power to The Nature Conservancy's Bridgestone Nature Reserve at Chestnut Mountain. The Nature Conservancy tasked us with finding a renewable source of energy for their property to lower their carbon footprint. Wind energy has many benefits, such as being renewable and producing much fewer carbon emissions than fossil fuel energy. However, Sparta, TN has much lower wind speeds than areas that effectively utilize wind power. Wind is also intermittent and may not align with demand. Wind turbines require regular maintenance, and any failure has the potential to destroy the turbine system. The small amount of electricity produced by the turbine would not offset the high installation and maintenance costs. At Sparta's average wind speed of 4.7 mph, a small wind electric system could have a potential payback period of over thirty years. Additionally, we identified two endangered bat species on the property that may be negatively impacted by a wind turbine. There is currently no system in place to easily recycle turbine parts at the end of their lives, and most of them end up in landfills. Ultimately, we decided that wind power would not be the best solution at this time.

Undergraduate Student

Learning the Land: Private Woodland Workshop

Primary Author: Charleston Pritchett, Environmental and Sustainability Studies

Co-Author(s)/Collaborators: Tim Cooper; Megan Flynn; Kati Lowe; Andrew Williamson; Tammy Boles, Tennessee Technological University - School of Environmental Studies; Steven Sharp, Tennessee Technological University - School of Environmental Studies

Advisor(s): Tammy Boles

In Tennessee, approximately 81% of forestland is privately owned. Many people throughout the upper Cumberland own forestland, but not all of them know how to manage it properly. We created "Learning the Land: Private Woodland Workshop" for those who own 10-100 acres. It will be held on April 23, 2022, at the Appalachian Center for Craft with guest speakers from both government offices and the private sector. They will speak in sessions on Forest Health, Plant Species Identification, Financial Management of Woodlands, and Landowner Resources for Cost-Sharing along with an outdoor workshop on Tree Identification. We plan for this event to be held annually to help forestland owners, especially women, further their knowledge about their property. To make this event, we collaborated with many other groups and individuals to market, make efficient modes of communication, create the event, and gather demographic information.

Undergraduate Student

Solar Energy for Bridgestone Nature Reserve at Chestnut Mountain

Primary Author: Rachel Reed, Environmental and Sustainability Studies

Co-Author(s)/Collaborators: Samantha Snyder; Luke Fraley; Ashley Daniel

Advisor(s): Steven Sharp

This project explores solar power generation systems as a potential renewable energy source for The Nature Conservancy's facility at Bridgestone Nature Reserve at Chestnut Mountain as a part of their goal to achieve carbon neutrality on the property. Initial research focused on the general function and composition of small-scale systems. Based on the energy usage listed on the energy audit provided by the Tennessee Valley Authority, the facility would require a 6-kWh photovoltaic (PV) system. A cost analysis revealed that the average cost of purchasing and installing this size system in Tennessee was $14,000. Energy storage options include sealed lead-acid batteries and lithium-ion batteries; however, cost analyses were not performed for storage options because The Nature Conservancy concluded that they do not plan to go off-grid. A reference sheet was constructed detailing this data and identifying potential installation companies for The Nature Conservancy to consult regarding quotes for the project. The next steps for the project will be obtaining quotes for the PV system, finalizing the decision of which company to hire, composing a case for support to raise funds for the project, and purchasing and installing the solar panel system.

Undergraduate Student

Development of Forest Health Curriculum for Private Landowners

Primary Author: Hayley Reed, Environmental and Sustainability Studies

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University - School of Environmental Studies; Steven Sharp, Tennessee Technological University - School of Environmental Studies

Advisor(s): Tammy Boles

Our team in the 2021-22 Environmental and Sustainability Capstone created curricula for several topics of interest to Upper Cumberland. Our primary focus was to help female private woodland landowners who may not have the resources available to them to learn their land better. Even though our main focus is women, our curriculum is open to anyone with the desire to learn. The topics we covered are: carbon sequestration, soil health, native and invasive plant species, plant species identification and foraging, and grants and funding. When managing their forestland, whether leaving the land be or harvesting timber, owners need to understand carbon sequestration and the identification and management of natural and invasive species. Soil health is vital to tree health. In addition, there are financial resources available to land owners, but most people do not know where to find the resources. The goal of this research is to provide resources for landowners that want to learn how to best care for their forestlands in this area.

School of Interdisciplinary Studies

Undergraduate Student

The Need for STEM Workshops and Clubs in Carter County Tennessee

Primary Author: Brandon Pierce, Business Management and Environmental Sustainability

Advisor(s): Ann Manginelli

STEM education is the 5th fastest growing industry in the south and Tennessee has a goal to become one of the top 25 states for STEM education. (STEM Strategic Plan [TNDOE], 2018). However, most of the funding for STEM education, goes to schools that are double in size and income that are larger and better funded. Tennessee STEM Innovation Network (TSIN) and Tennessee Department of Education (TNDOE) have outlined the need for more STEM activities in communities and the need to bridge the gap between local universities and rural public schools, with additional highlighted needs for more educators to be proficient in STEM education (TNDOE, 2018).

According to the United States Government Accountability Office (2019), the Carter County population in 2020 was approximately 56,356 individuals. The Census Bureau listed $38,092 as the median household income in 2019. Even though the need for STEM education increases every year, the funding has not kept pace for rural public schools in Carter County.

The focus areas of my project are 1) identification of problems and solution options for STEM education activities in Carter County; 2) development of an online STEM activity curriculum with tutorial videos for at-home activities, after-school program activities for three elementary partnerships, and community events; and, 3) creation of connections with local universities, businesses, and schools to ensure children in Carter County have multiple options for STEM education activities.

Citations

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Whitson-Hester School of Nursing

DNP

Implementation of an ADHD Electronic Portal in Pediatric Primary Care

Primary Author: Heather Cathey, Nursing DNP

Advisor(s): Bedelia Russell

Clinical practice guidelines (CPGs) for Attention Deficit Hyperactivity Disorder (ADHD) recommend documentation of symptom scales and comorbidity screenings at the time of diagnosis and routinely throughout care. Rates of documentation for these tools in pediatric primary care are consistently low, creating a gap in care that impairs diagnosis, management, and patient outcomes. The purpose of this quality improvement project was to implement an online ADHD portal that emails, collects and scores these tools. The aims of the project are to improve utilization of CPGs by increasing documentation rates of symptom scales and comorbidity screenings for pediatric patients with ADHD. One primary care pediatrician located in Middle Tennessee piloted the project, with the goal to expand this to additional partners in the future. Following submission to the IRB, the committee determined this type of quality improvement project to not require their oversight. A six-month retrospective chart review was conducted to determine baseline rates of documentation for the two outcomes. During the ten-week project, the portal was activated and evaluation tools were sent. A second chart review will be conducted at the conclusion of the project to determine if rates of documentation have improved. The expected outcomes include successful implementation of the online portal with improved CPG utilization related to increased rates of documentation for symptom scales and comorbidity assessments.

Undergraduate Student

Ketamine Treatment for Veterans with Post Traumatic Stress Disorder

Primary Author: Haley Bearden, Nursing

Co-Author(s)/Collaborators: Lynette Harvey

Advisor(s): Lynette Harvey

Currently, 87% of veterans are exposed to traumatic events. Veterans that are diagnosed with Post Traumatic Stress Disorder (PTSD) are 58% more likely to commit suicide than those without PTSD. SSRI antidepressants are the only first line pharmacological treatment for PTSD, and they only achieve remission of symptoms in 20-30% of patients. Ketamine, a medicine previously used as an anesthetic, was recently FDA approved to treat depression. Trials are being conducted showing favorable results in treating veterans with PTSD. Ketamine treats depression by antagonizing NMDA receptors in the brain, these same receptors are believed to play a role in PTSD symptoms and severity. The purpose of this focused literature review was to find the significance of ketamine treatments in veterans suffering from PTSD. In this focused literature review 8 quantitative articles and 2 qualitative articles were found using the keywords “ketamine”, “therapy”, and “PTSD”. The 8 quantitative articles reveal that both veterans and civilians experienced reduction of PTSD severity and symptoms, suicidal ideation, depression, and even maladaptive alcohol consumption after receiving ketamine treatments. The two qualitative articles revealed both veterans and civilians self-reporting a reduction in PTSD, depression, and suicidal ideation during and after ketamine treatments. These studies give promising evidence that raise hope for ketamine as a novel treatment for PTSD.

Whitson-Hester School of Nursing

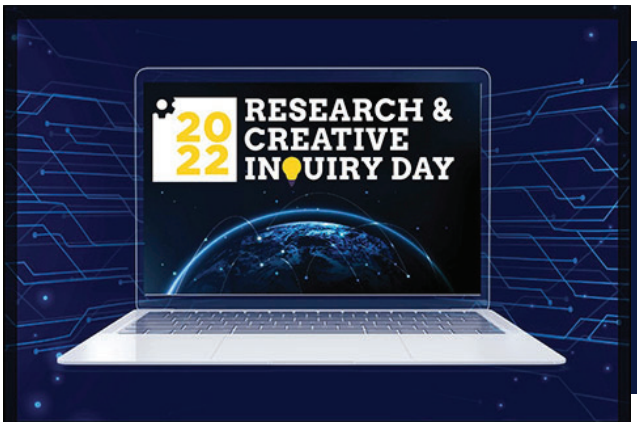
Undergraduate Student

The Cytokine Storm in COVID-19 and Promising Treatment Options

Primary Author: Taylor Hornback, Nursing

Advisor(s): Susan Piras

COVID-19 continues to be a worldwide health issue or pandemic since November 2019 causing acute respiratory failure and multi system organ failure in many individuals. One of the main contributors to acute respiratory failure and multi organ failure, is “The Cytokine Storm” which occurs in 20-30% of hospitalized individuals approximately seven days after a positive COVID-19 test. This cytokine storm is made of proinflammatory cytokines which are protein substances secreted by the body’s immune system cells. The cytokines wreak havoc among many organ systems, and they are ultimately reported as the main cause of death in patients with COVID-19. When these cytokines are released, alterations in the body and specifically the lungs occur such as fibrinous exudates, inflammatory infiltrates, alveolar injury, pulmonary edema, and pulmonary embolisms in severe cases. My research findings have shown some promise in new drugs such as monoclonal antibodies, intravenous immunoglobulin (IVIG), TNF blocker, antimalarials, many more immunosuppressant drugs, and even plasmapheresis via an extracorporeal membrane oxygenation (ECMO). The ultimate goal of care is to understand the cytokine storm and halt the excessive cytokine release. Many patients who have died due to COVID-19 were not treated in a timely manner with the appropriate treatment. The key to survival could be early detection and intervention to counteract the systemic inflammatory response and decrease the release of cytokines.



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."

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