2023 In-Person EUREKA! Project List

The following list contains the projects available for the 2023 In-Person EUREKA! Program. Project details are available in the pages following this list.

Department	Project Title
Accountancy	Forensic Accounting
Agricultural Sciences and Animal and Veterinary Sciences	Economics and Outreach of Climate-Smart Agricultural Practices for Forages and Livestock Systems
Animal and Veterinary Sciences	Host-pathogen Interactions in Campylobacter Infections in Chickens and Humans
Automotive Engineering	Modeling and Control of Scaled Connected and Autonomous Vehicles
Automotive Engineering	Artificial Intelligence for Intelligent Vehicle Driving Safety
Bioengineering	Cancer Nanomedicine
Bioengineering	Bovine In Vitro Fertilization and Embryo Culture
Biological Sciences	Development of Fluorescent and Luminescent Histomanos meleagridis for Drug Development Against a Turkey Protozoan Pathogen
Chemistry	Anabolic Steroids: Advanced Analytical Methods for Detection and Quantification
Chemistry	Paper-Derived Carbon Electrodes, a Versatile Option to Develop Electrochemical Sensors
Chemistry	Observing RNA Sugar Pucker Using Single-Molecule Atomic Force Microscopy
Chemistry	Building Legos at Molecular Level - Synthetic Organic Chemistry Using Multi-Catalysis
Chemistry	From Cocrystals to Deep Eutectic Solvents: The Continuum of Halogen Bonding from the Solid to the Liquid State
Computing	Machine Learning-based Online Abuse Detection
Computing	Ensuring Privacy and Policy Compliance in Smart Speaker Systems
Computing	Physics-Based Deep Learning for Computer Vision
Computing	Machine Learning in Recommendation System
Computing	Fingerprinting Automotive ECUs Using Physical-Layer Characteristics

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Department	Project Title
Engineering & Science Education	Understanding the Experiences of Neurodivergent Learners in Higher Education
Environmental Engineering and Earth Sciences	Sustainability: Techno-Economic Assessment of Solar PV System
Environmental Engineering and Earth Sciences	Electrification of Water Treatment Processes for Resource Recovery
Genetics and Biochemistry	The Molecular Response of Poplar to Sphaerulina musiva, a Fungal Pathogen
Genetics and Biochemistry	Biotechnology - Crop Genetic Engineering for Enhanced Agricultural Production
Genetics and Biochemistry	DNA Repair and Genome Instability
Genetics and Biochemistry	AI in Biomedicine: Prediction of Novel Human Disease Genes by Genomic Data Mining
Materials Science and Engineering	Computational Materials Science Coupled with Data Science for the Design of Multi-Principal Element Alloys
Mechanical Engineering	Not All Cellulose is Made the Same... Plant Cellulose vs. Bacterial Cellulose, Which One is More Sustainable?
Mechanical Engineering and Bioengineering	Computational Cardiovascular Research
Nursing	Project SUNDAYS: Engaging Rural African American Religious and Spiritual Leaders on Advance Care Planning
Nursing	The Effects of Mediterranean Herb Extracts on Breast Cancer Cells and Assessment of their Metabolic Profiles
Nursing	Facilitators and Barriers to Using Telepresence Robots in Healthcare Settings
Plant and Environmental Sciences	Understanding Seasonal Nutrient Uptake of Fruit Trees
Plant and Environmental Sciences	Climate Resilient Crops for Food Security
Plant and Environmental Sciences	Elucidating the Effect of Plant Chemistry on Soil Carbon Chemistry
Psychology	Attitudes Toward Advanced Vehicle Technologies

Project Title: Forensic Accounting
Mentor: Mary Gibson, Lecturer
Department: Accountancy

Project Description:

The student will review peer-reviewed articles on fraud awareness and prevention. The student will look for gaps in the research for further study. The student will look at a data set and run basic statistical analysis such as Chi Square to look for relationships between variables (such as does having a whistle-blower program correlate with reduction in fraud occurrence).

Student Involvement:

The research interns will pull peer-reviewed articles and dissertations on accounting fraud. The intern will sort the articles in Excel or Word. The intern will summarize the articles in an annotated bibliography.

Required Skills or Equipment:

The intern should have strong research skills and able to understand the difference between peer-reviewed and news articles. The intern should understand APA and have good grammar. The student should be able to run basic statistical calculations. Students should also have experience with SPSS or Excel statistical programs.

Expected Outcomes:

The students should be able to publish the writings and present at conferences such as the American Accounting Association or Academy of Business Research upon completion of the project.

Future Opportunities:

The students would be welcome to continue their research in the fall.

Research Location:

On-campus in the Power's Building

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Project Title: Economics and Outreach of Climate-Smart Agricultural Practices for Forages and Livestock Systems

Mentor: Ana Thayer, Assistant Professor

Department: Agricultural Sciences and Animal and Veterinary Sciences

Project Description:

Participants will work jointly with Dr. Thayer of the Agricultural Sciences Department and Dr. Silva of the Animal and Veterinary Sciences Department to understand the factors and attributes of producers that expresses interest in the Climate-Smart commodities partnership as well as develop educational resources and support the Extension program by contributing to existing programming activities.

Student Involvement:

The interns will work with Dr. Thayer to prepare relevant comparisons, figures and visualizations. The interns will work with Dr. Silva for hands on activities including but not limited on preparing handouts and material for Extension events or demonstrations in the field, develop relevant educational materials, and interact with Extension agents and producers.

Required Skills or Equipment:

It is preferred that students possess knowledge of Microsoft Excel, Word and PowerPoint.

Expected Outcomes:

Students will be able to co-authors publications, blog posts, and outreach material (handouts) upon completion of the program.

Future Opportunities:

There is potential for students to continue to work on the project after the end of EUREKA!, pending availability of resources (assistantship, etc.).

Research Location:

On-campus

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Project Title: Host-pathogen Interactions in Campylobacter Infections in Chickens and Humans

Mentor: Khaled Abdelaziz, Assistant Professor

Department: Animal and Veterinary Sciences

Project Description:

Campylobacter is one of the leading bacterial causes of diarrheal illness in the US. According to the Center for Disease Control and Prevention (CDC), "there are about 1.3 million cases of Campylobacter infection each year in the US alone." It is estimated that over 90% of all human cases of campylobacteriosis originate from farm animals. While Campylobacter infection in farm animals is not associated with any clinical signs, its transmission to humans, via contaminated animal products, causes acute enteritis. While several Campylobacter virulence factors have been identified, the lack of understanding of how this pathogen utilizes these factors to circumvent host immune surveillance and cause disease in humans has halted the development of innovative ways to prevent and treat Campylobacter infection in humans. A better understanding of host-Campylobacter interactions will help pinpoint specific bacterial and host targets for therapeutic interventions and vaccine development.

Student Involvement:

Students will investigate the differential responses of chicken and human macrophages to Campylobacter jejuni. They will profile the expression of the immune system genes in macrophages in response to Campylobacter infection. During the training period, students will learn microbiology and advanced molecular biology techniques including tissue culture, RNA extraction, complementary DNA synthesis, Real-time Polymerase chain reaction (RT-PCR), and culturing and counting Campylobacter.

Required Skills or Equipment:

None

Expected Outcomes:

Students will have the opportunity to present the generated data in symposia and conferences. I also expect to publish the obtained findings in a peer-reviewed journal.

Future Opportunities:

If the students demonstrate a satisfactory performance during the training period, there is a possibility that they will continue their training in my lab after the program is complete.

Research Location:

On-campus in the Poole Agriculture Center

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Project Title: Modeling and Control of Scaled Connected and Autonomous Vehicles

Mentor: Venkat Krovi, Michelin SmartState Chair Professor of Vehicle Automation

Department: Automotive Engineering

Project Description:

F1/10 is a shared, open-sourced infrastructure for the development and validation of new approaches to autonomous perception, planning, control and coordination. This community platform will facilitate autonomous system research, education and bench-marking through the creation of a new class of high-performance autonomous racing cars, that are 1/10th the size of a real (Formula 1) car and can reach a top speed of 50 miles per hour. The goal is to enable a wide range of experimental research and education in Safe, Secure, Coordinated and Efficient Autonomy. You can find out more on the NSF page: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1925500.

Student Involvement:

Interns will be individually involved in developing and simulating Computer Aided Engineering (CAE) robot models of the vehicles as well as assisting with programming in MATLAB/Python and testing in simulation/real-world settings.

Required Skills or Equipment:

Basic knowledge of linear algebra and trigonometry is required. Experience in programming is a plus.

Expected Outcomes:

Intern(s) will develop the ability to program in MATLAB/Python, develop CAD models in Solidworks/Simulation Tools, make technical presentations, and participate in team-based research throughout the course of the program.

Future Opportunities:

Upon completion of the project, interns will have the potential to pursue an REU and other internship opportunities.

Research Location:

Off-campus at CU-ICAR in Greenville, SC

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Project Title: Artificial Intelligence for Intelligent Vehicle Driving Safety

Mentor: Bing Li, Assistant Professor

Department: Automotive Engineering

Project Description:

The interns will explore Artificial Intelligence existing technologies for intelligent vehicle driving safety.

Student Involvement:

The interns will conduct surveys, might run programs, and write reports to further our project.

Required Skills or Equipment:

Python programming skills are preferred.

Expected Outcomes:

After the project, the students will create a presentation, report, and have the potential for software development.

Future Opportunities:

Students will be able to publish their results upon completion of the project.

Research Location:

Off-campus at CU-ICAR in Greenville, SC

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Project Title: Cancer Nanomedicine
Mentor: Angela Alexander-Bryant, Assistant Professor
Department: Bioengineering

Project Description:

Cancer remains one of the most challenging diseases to treat, with a wide range of therapeutic options available, including chemotherapy, radiation therapy, immunotherapy, and targeted therapy. However, traditional cancer treatments often cause systemic toxicity and adverse side effects due to their non-specific distribution in the body. To overcome these limitations, drug delivery strategies have been developed to deliver anti-cancer drugs selectively to cancer cells, while minimizing damage to healthy tissues. The goal of this summer project is to develop innovative drug delivery systems to advance cancer treatment.

Student Involvement:

Students will learn how to culture cells and synthesize nano- and/or micro-scaled delivery systems for cancer therapeutics. Students will characterize these delivery systems in their unloaded and therapeutic-loaded forms. Students will examine the anticancer activity of their delivery systems on various cancer cell lines.

Required Skills or Equipment:

High school biology with knowledge of math needed for unit conversions is required. Students should also be proficient in Microsoft Excel.

Expected Outcomes:

By the end of the project, the student will know how to culture cells, synthesize peptide-based delivery systems, characterize the delivery system (i.e. size, stability, etc.), perform cell viability and uptake assays, present their research, perform a literature search, and write an abstract.

Future Opportunities:

Students that excel in the research may have the opportunity to join the lab to long-term research projects with the possibility for authorship on publications.

Research Location:

On-campus

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Project Title: Bovine In Vitro Fertilization and Embryo Culture

Mentor: Celina Checura, Adjunct Faculty/Research Scientist

Department: Bioengineering

Project Description:

Successful reproduction of livestock is critical for the economic livelihood of farmers and affects the consumer cost of meat and other animal products. In vitro-production of embryos is one of many assisted reproductive technologies having a positive impact on bovine production systems. This technique has several advantages over the recovery of in vivo-derived embryos, but in vitro maturation (IVM), in vitro fertilization (IVF) and in vitro culture (IVC) procedures need further improvement. In this project, we propose to alter mitochondria activity during oocyte (the female egg) maturation. We will test different additives as well as light protocols during oocyte maturation and measure the subsequent changes in embryonic development. A significant increase in embryonic development will make the in vitro production system more efficient, reducing costs for bovine producers and their customers. In the process, we will also increase our understanding of the basic physiology of the oocyte during the maturation process.

Student Involvement:

First, the students will become familiarized with the protocols for biosafety and laboratory work. Then, they will learn laboratory techniques by working along the instructor and other team members. The student/s will be assigned a small project and will be responsible of the embryo production under experimental conditions, guided by the instructor and senior team members.

Required Skills or Equipment:

Basic knowledge of cell biology and animal reproduction are required. The student should be comfortable handling slaughterhouse-derived biological material (mainly bovine ovaries).

Expected Outcomes:

By the end of the program, the students would have learned the scientific method, scientific bases of the embryo culture system, and have acquired some technical skills. They should be able to analyze and interpret the data collected and prepare an abstract/poster for presentation.

Future Opportunities:

Students can enroll in our Creative Inquiry course to continue working in this research line.

Research Location:

On-campus

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Project Title: Development of Fluorescent and Luminescent Histomanos meleagridis for Drug Development Against a Turkey Protozoan Pathogen

Mentor: Zhicheng Dou, Associate Professor

Department: Biological Sciences

Project Description:

Histomonas meleagridis is a single-celled pathogen of turkeys and other poultry species, causing significant economic losses in the poultry industry. It is the causative agent of histomoniasis, a lethal disease known as blackhead for turkey. This parasite primarily affects the liver and the ceca (part of the intestine) of infected birds, causing a range of symptoms such as diarrhea, lethargy, decreased appetite, and death. Current antibiotic treatment against histomoniasis is very limited. Therefore, there is an urgent need to develop novel antibiotics to treat histomoniasis. Currently, evaluation of Histomonas growth relies on manual counting by microscope, which is a time-consuming process and a limiting step for large-scale screening of chemical inhibitors. In this study, we propose to introduce the genes expressing fluorescence or luminescence into Histomonas parasites. These strains will serve as convenient tools for high throughput drug screening for the future development of novel antibiotics.

Student Involvement:

The proposed work plans to recruit two interns this summer. Both interns will be grouped as a team for the study. The interns will learn bench techniques under the guidance from the lab principal investigator, postdoc, and graduate students during the EUREKA! training program, such as PCR, DNA digestion and ligation, plasmid preparation, microscope handling, and fluorescence and luminescence assays. Both interns will be grouped as a team for the proposed study. At the end of this program, the interns will give oral presentations individually in the lab meeting and outside professional meetings if selected.

Required Skills or Equipment:

Basic knowledge of molecular biology and biochemistry learned at the high school is required. Skills of PCR, gel electrophoresis, and basic microscope handling are preferred, but not required.

Expected Outcomes:

The students will learn the latest genome manipulation skills and parasite culturing and handling. They are expected to give oral presentations for their research findings generated in the summer. The data they generated may be included in future publications.

Future Opportunities:

Upon successfully completing the EUREKA! program, the interns can continue participating in the lab research activities in my lab or other molecular biology labs at Clemson. In addition, the interns will be competitive for other future summer research programs, such as REU.

Research Location:

On-campus

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Project Title: Anabolic Steroids: Advanced Analytical Methods for Detection and Quantification

Mentor: Christopher Chouinard, Assistant Professor

Department: Chemistry

Project Description:

Anabolic steroids are frequently abused by athletes seeking to gain an unfair advantage in sport (i.e., doping). For the last several decades, mass spectrometry-based methods have been the technique of choice for detecting doping violations, usually via analysis of athlete urine samples. Our research group focuses on developing the next generation of analytical methods for anti-doping.

Student Involvement:

Students will work with the faculty member and chemistry graduate student(s) to learn about the standard process for detecting anabolic steroids in human urine. This will include sample preparation, analysis by advanced mass spectrometry methods, and data processing/presentation.

Required Skills or Equipment:

No specific skills, experiences, or knowledge are required. 'On-the-job' training will be provided by the team during (roughly) the first two weeks to allow the intern to be semi-independent during the remainder of the project.

Expected Outcomes:

It is expected that the intern work to help develop a targeted method for an anabolic steroid metabolite(s). By the conclusion of the project, the intern will have a completed a quantitative analysis that will demonstrate limits of detection, sensitivity, and selectivity (differentiation from interferences) for that steroid in human urine. The intern will learn general sample preparation techniques (pipetting, dilution, solid-phase extraction, etc.), liquid chromatography and high resolution mass spectrometry analysis, and data presentation means (creation of figures/tables for poster or manuscript). The ultimate goal is that this work will be included in a peer-reviewed publication to be submitted shortly after completion of the summer program.

Future Opportunities:

Our research group seeks to recruit enthusiastic undergraduate researchers, as early in their career as possible (generally no later than their junior year). If there is success in the project and mutual interest, there would absolutely be an opportunity for the intern to continue these studies long-term in our research group. Opportunities would certainly include research for credit (or possibly pay, depending on group funding status), and potentially even conference travel to present results (e.g., Southeastern Regional Meeting of the American Chemical Society).

Research Location:

On-campus in Hunter Hall

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Project Title: Paper-Derived Carbon Electrodes, a Versatile Option to Develop Electrochemical Sensors

Mentor: Carlos Garcia, Professor

Department: Chemistry

Project Description:

Carbon-based materials are particularly well-suited for electroanalytical applications due to their distinct properties, such as high chemical stability, large electroactive areas, wide electrochemical potential window in aqueous solutions, low electrical resistance, rich surface chemistry, and activity towards a variety of redox reactions. While carbon electrodes can be produced via thermal decomposition of gaseous hydrocarbons followed by their surface-induced recombination, this method is not cost-effective and suffers from both low efficiency (~20%) and limited selectivity towards graphitic forms. Alternatively, carbon electrodes can be developed via pyrolytic treatment of non-volatile substrates. This approach yields carbon materials that are rich in graphitic phases and provides researchers a much richer selection of starting materials and source-to-product efficiencies ~70%. Our team has applied this approach to develop several optically transparent carbon electrodes and has described a method for fabricating carbon electrodes by pyrolysis of paper, using a tube furnace and under a mild reducing atmosphere. The resulting electrodes not only feature the properties of traditional carbon materials but also preserve the 3D structure of the starting material, are mildly hydrophobic, and offer a wide electrochemical window and can be patterned using laser engraving. Moreover, the process also enables the incorporation of metallic nanoparticles within the structure of the material (by pyrolyzing paper pre-soaked in a solution containing the selected cation), significantly improving the conductivity of the material.

Student Involvement:

Students working in this project will learn to fabricate sensors and become familiar with the reactions leading to the application of the sensors towards their use in microfluidic devices. Special emphasis will be placed on the use of these electrodes for the detection of bacteria, application that required the modification of the material with a thin layer of sputtered gold (that minimizes lateral resistivity and significantly improves the electron transfer process) and with chitosan (used as a binder to offer flexibility).

Required Skills or Equipment:

Basic knowledge in general chemistry is required.

Expected Outcomes:

After completion of the project, students will create a presentation of their work and potentially have the opportunity to publish their findings.

Future Opportunities:

Students will be able to continue working on this project or join other projects in the lab.

Research Location:

On-campus in Hunter Hall

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Project Title: Observing RNA Sugar Pucker Using Single-Molecule Atomic Force Microscopy

Mentor: David Jacobson, Assistant Professor

Department: Chemistry

Project Description:

The nucleic acids (DNA and RNA) store and transmit genetic information in cells. Although both have similar chemical structures consisting of an alternating backbone of phosphate groups and sugar rings with attached bases, subtle differences cause the RNA sugar to occur in a compact configuration whereas the DNA sugar occurs in an extended configuration (referred to as having different "sugar pucker"). Quantum chemistry calculations have predicted the degree of thermodynamic stability of the compact configuration in RNA, but no experimental measurements have tested this value. The goal of this project is to use an atomic force microscope (AFM) to exert mechanical force on an RNA chain to induce the transition between compact and extended sugar pucker. The force at which this transition occurs will reflect the energetic difference between the configurations, since work equals force times distance. Such information would contribute to the basic physical-chemical understanding of one of the most important molecules in biology.

Student Involvement:

The major tasks the student will undertake will be (1) preparing a single-stranded RNA sample using molecular biology/biochemical techniques, (2) confirming size and purity of the sample using gel electrophoresis, (3) using surface chemistry to attach the sample to a glass substate and to the AFM cantilever, and (4) performing the AFM experiment itself.

Required Skills or Equipment:

No specific prior skills, other than an interest in chemistry/biophysics, are required.

Expected Outcomes:

The project will expose the student to basic biological and chemical laboratory techniques, as well as to using cutting-edge single-molecule biophysics approaches.

Future Opportunities:

It is hoped that the student will want to continue this research during their time at Clemson, leading to a publication of their results in the scientific literature. Beyond the basic measurement of thermodynamic stability, there are interesting questions

to be asked about how nucleic-acid sugar pucker depends on the sequence of bases, which are the part of the molecule that contain the genetic information.

Research Location:

On-campus in Hunter Hall

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Project Title: Building Legos at Molecular Level - Syntethic Organic Chemistry Using Multi-Catalysis

Mentor: Byoungmoo Kim, Assistant Professor

Department: Chemistry

Project Description:

Organic Chemistry is just like Legos; diverse molecules can be made from simple chemical building blocks. Among many classes of molecules, amines are particularly important and useful because they are prevalent in therapeutic drugs and biologically active molecules. The Kim Group is interested in developing an efficient method to make various amines using multi-catalysis, which is a great way to accelerate chemical processes. In this project, we will aim to design and explore a new class of catalysts for the amine synthesis.

Student Involvement:

The research intern(s) will be directly mentored/trained by a graduate student. They will work as a team to carry out various chemical reactions, learn new laboratory techniques, and discuss fundamental relevant concepts.
We will aim to follow the schedule below:
Week 1: Safety training, discussion on "what is organic chemistry, catalysis?", shadow graduate student and learn basic laboratory techniques, such as extraction and column chromatography.
Week 2: Learn how to set up organic chemical reactions by repeating the mentor's previously performed experiments.
Week 3-4: Explore new catalytic reactions for amine synthesis, work on the poster presentation.

Required Skills or Equipment:

No particular technical skills are required; all required skills will be taught by the mentor. Based on the nature of organic chemistry, this project will mostly involve hands-on lab experiments. It will be like you are baking or cooking but with chemicals. Someone who has taken chemistry coursees is preferred but not required.

Expected Outcomes:

The research intern(s) will learn how to build new chemical compounds using organic chemistry - basically, you are an architect with molecules. Throughout the program, you will develop teamwork and problem-solving skills. Depending on the research contribution, the intern(s) will be a part of co-authors in the publication. Lastly, you will gain better appreciation for various beneficial roles of diverse chemicals in our lives.

Future Opportunities:

Given the availability of lab space and the intern(s)' interest, they could continue to work in the Kim Group throughout the school year or as a full-time summer research assistant.

Research Location:

On-campus in Hunter Hall

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Project Title: From Cocrystals to Deep Eutectic Solvents: The Continuum of Halogen Bonding from the Solid to the Liquid State

Mentor: William Pennington, Alumni Distinguished Professor, Department Chair of Chemistry

Department: Chemistry

Project Description:

Crystallographers like crystals. So much so that any other state of matter is automatically assumed to be a failure. Halogen-bonding (X-bonding) is the attraction of a nucleophilic region of one atom, ion or molecule to the electrophilic region of a covalently bonded halogen atom, located opposite the bond to the halogen atom. X-bond strength increases with the polarizability of the halogen atom, and we have concentrated much of our efforts on X-bonding interactions between sulfur and selenium as X-acceptor (electron-pair donor) and iodine (typically bonded to carbon) as the X-donor (electron-pair acceptor). Over the course of our studies we have often had combinations of X-donors and X-acceptors defy all efforts to form cocrystals, either refusing to crystallize together so that only starting reagent crystals are formed or by not forming crystals at all. Failures of the former type provide a great challenge for finding the right solvent or solvent mixture, best ratio of donor to acceptor, the right person for the job, etc. Those of the latter usually end up in the trash bin (just kidding – they actually end up in OSHA-approved hazardous waste containers properly labeled and stored in a stable, safe location). After years of suffering these occasional disappointments, we realized that other than our systems being X-bonded, they are very similar to H-bonded systems that act as deep eutectic solvents (DESs). We then began to study the liquids instead of throwing them away and found that many do indeed act as DESs. Several structures of S/Se···I cocrystals will be discussed as well as the preparation and characterization of X-bonded DESs.

Student Involvement:

Working under the guidance of a graduate student, each intern will be assigned a range of donor molecules and acceptor molecules to study in order to survey the compositional landscape of combinations of these donors. The various donors and acceptors will be combined in different molar ratios and dissolved in various solvents. Any crystals resulting from the slow evaporation of solvent will be analyzed by X-ray diffraction analysis. In parallel, the donor and acceptor molecules will be ground together in a mortar and pestle. If a solid powder forms, it will be analyzed to determine whether it is the same product as that grown from solution. If a liquid forms, it will be studied by thermal analysis methods and spectroscopic

techniques to determine whether it has the properties of a deep eutectic solvent. Ultimately DESs will be analyzed for carbon dioxide capture or other applications.

Required Skills or Equipment:

A working knowledge of basic algebra is helpful for doing stoichiometric calculations. Any other skills, information or techniques will be taught.

Expected Outcomes:

Last year we had seven undergraduate and high school students working on this project. They were able to produce an enormous number of exciting results. We are currently writing papers based on these results, and the students involved will be coauthors. We also hope that our interns will be interested in presenting their results at conferences, for which we will provide support. One of the students from last year presented her work at an American Chemical Society conference in San Juan, Puerto Rico!

Future Opportunities:

While we advise all of our students to be careful to not get overextended during their first semester, we are also delighted for them to continue work on their projects with our research group.

Research Location:

On-campus in Hunter Hall

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Project Title: Machine Learning-based Online Abuse Detection

Mentor: Long Cheng, Assistant Professor

Department: Computing

Project Description:

Online abuse (such as cyberharassment, cyberbullying, online extremism, and disinformation) is identified as a pressing social problem since it has the potential to negatively impact the safety and psychological well-being of targeted groups, radicalize people and incite violence, and manipulate public opinion. Artificial intelligence (AI) has immense potential for automatic detection of online abuse. In this project, we will apply AI techniques to detect different types of online abuse in online social media such as Twitter.

Student Involvement:

The interns will work with PhD students tol learn data collection from Twitter using existing tools (e.g., Tweepy and Snscrape), data annotation, state-of-the-art machine learning-based online abuse detectors. Students will also learn the main evaluation metrics of a machine learning-based classifier, such as false positives, false negatives, precision, recall, and F1 score.

Required Skills or Equipment:

Basic Python programming skills are required.

Expected Outcomes:

In addition to learning about AI models and evaluation metrics, the students will also create a poster presentation about the research work.

Future Opportunities:

Students may continue with this research project funded by the NSF REU program.

Research Location:

On-campus

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Project Title: Ensuring Privacy and Policy Compliance in Smart Speaker Systems

Mentor: Long Cheng, Assistant Professor

Department: Computing

Project Description:

Voice personal assistants (VPAs) such as Amazon Alexa and Google Assistant are rapidly gaining in both domestic and business popularity. Despite the many convenient features, concerns have been raised about the security risks (in particular privacy and content safety) to VPA users. In this project, we will design a dynamic analysis framework to evaluate how existing voice-applications conform to various policy requirements and measure potential social bias issues in mainstream VPA platforms.

Student Involvement:

Students will work with a PhD student in this project to learn Privacy and Policy requirements such as Children's Online Privacy Protection Act (COPPA) and General Data Protection Regulation (GDPR). The constrained interfaces on Smart Speaker devices pose a challenge to effective privacy notices. Privacy policies are only available on the store's webpages, and thus they are inaccessible to users who only use Smart Speaker services through the conversational interface. This, in particular, creates a challenge for visually impaired users to make informed privacy decisions considering Smart Speaker's use by people with special needs is growing. Students will be involved in designing and developing an inclusive and effective privacy notice mechanism for smart speaker users.

Required Skills or Equipment:

Students should be familiar with Python programming.

Expected Outcomes:

The expected outcomes include a poster presentation about the research work.

Future Opportunities:

Students may continue doing the research after the EUREKA! program.

Research Location:

On-campus

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Project Title: Physics-Based Deep Learning for Computer Vision

Mentor: Nianyi Li, Assistant Professor

Department: Computing

Project Description:

The goal of this project is to teach students how to use physics-based deep learning for computer vision. Computer vision is the science of making computers see and interpret the world like humans do. In this project, we will focus on using deep learning, which is a type of artificial intelligence that allows computers to learn from data and improve their accuracy over time.

We will use the principles of physics to teach the computer how to recognize and interpret visual data. For example, we can use physics to help the computer understand how objects move in space and time, which is crucial for many computer vision applications. By combining this physics knowledge with deep learning, we can create models that can accurately predict the movement of objects in videos or images.

The project will involve using Python programming language and learning basic machine learning and deep learning algorithms. Students will learn how to use these tools to build and train their own deep learning models. They will also learn how to test and evaluate the accuracy of their models using real-world data.

Student Involvement:

Our research interns will play a critical role in this project. They will work both individually and as a team to learn the principles of physics-based deep learning for computer vision. Specifically, they will learn how to use Python programming language and basic machine learning and deep learning algorithms to build, train, and test their own deep learning models. They will also be responsible for collecting and analyzing real-world data to evaluate the accuracy of their models.

Required Skills or Equipment:

To participate in this project, research interns will need a basic understanding of mathematics, including linear algebra and calculus. They should have some prior experience with programming, preferably in Python, which will be the primary language used in this project. Additionally, familiarity with basic machine learning concepts and deep learning frameworks such as TensorFlow or PyTorch would be beneficial. However, we welcome students with diverse backgrounds and skill sets who are eager to learn and contribute to the project. Students who are self-motivated, curious, and able to work well in a team environment will excel in this project.

Expected Outcomes:

The expected outcomes of the program are to provide research interns with the skills and knowledge necessary to contribute to research in the field of physics-based deep learning for computer vision. By the end of the program, interns should have a solid understanding of Python programming, basic machine learning concepts, deep learning algorithms, and the application of these tools to solve problems in computer vision. Through their involvement in the program, interns will gain valuable research experience that will prepare them for future academic and professional pursuits in physics, computer vision, and machine learning. They may also develop new software tools or applications that could have practical applications in various industries. While we cannot guarantee that the program will lead to a publication, interns will be well-equipped to produce high-quality research that could be suitable for publication in relevant academic journals. At the end of the project, students will present their findings at a poster forum and are encouraged to present their research at a professional meeting, such as the SC Academy of Science. This project will provide students with valuable research methods and skills in the fields of physics, computer vision, and machine learning, which can be applied in a variety of industries and career paths.

Future Opportunities:

Completing the research experience could lead to further research opportunities in the same or related fields. Students could pursue additional research experiences as undergraduate researchers, or they could apply to graduate programs in physics, computer science, or related fields.

Research Location:

Off-campus at CU-ICAR in Greenville, SC

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Project Title: Machine Learning in Recommendation System

Mentor: Kai Liu, Assistant Professor

Department: Computing

Project Description:

How do you recommend movies to those who may have interest? One of the most widely used methods in practice is via Matrix Factorization, which usually involves with Singular Value Decomposition (SVD). However, when the data is in large scale, SVD becomes impractical due to its heavy computation demand. In this project, we are going to investigate an SVD-free algorithm, and conduct experiments on Movie Lens dataset (or any other datasets if applicable) and evaluate the performance of the algorithm including accuracy and speed.

Student Involvement:

Students will collect dataset they are interested in (not limited to movie review data), write the proposed algorithm with codes and conduct experiments to evaluate the performance of our proposed algorithm.

Required Skills or Equipment:

Students should have experience with Matlab/Python, linear algebra, and matrix analysis.

Expected Outcomes:

If possible, we expect this experiment to be part of a paper we submit to a top-tier Machine Learning/Data Mining conference such as the International Conference on Data Mining.

Future Opportunities:

Students will have the opportunity to publish a paper, which will be extremely helpful if they are going to apply for graduate school.

Research Location:

On-campus in McAdams Hall

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Project Title: Fingerprinting Automotive ECUs Using Physical-Layer Characteristics

Mentor: Mert Pesé, Assistant Professor

Department: Computing

Project Description:

With the rise of self-driving cars, these are getting increasingly connected. In recent years, more and more vehicles are becoming targets of cybersecurity attacks. Attackers can remotely compromise cars and make them misbehave, causing significant financial damage to the car, as well as to the safety of the driver. In this project, we are going to study the communication protocols of in-vehicle microcontrollers and work on a countermeasure to thwart aforementioned attacks. Students will gain hands-on experience in coding microcontrollers such as the Arduino on a realistic testbed, as well as learn how to use oscilloscopes to understand how cyberattacks can be prevented.

Student Involvement:

Research interns will work with the faculty and a graduate student who are experts on in-vehicle communication security. In the first week, they will learn the basics of operating an oscilloscope and programming an Arduino. We will observe on the testbed how microcontrollers in a vehicle exchange data with each other and how an attacker can corrupt the communication. After that, the students will measure voltage levels of the communication on an oscilloscope and understand how the protocol works on the physical layer. The faculty will explain why certain phenomena happen (we do not assume any electrical engineering knowledge, so we will not go into detail) and the students will capture the recordings through the USB interface of the oscilloscope. Students will then proceed to analyze the data points collected by the oscilloscope's computer software. The faculty will teach interns how to calculate statistics from the data and the basics of machine learning classification algorithms. Students will train machine learning classifiers on the data and be able to distinguish the data sent from a microcontroller from the transmission of others. This is called fingerprinting. As a result of fingerprinting, students will be able to distinguish malicious microcontrollers from benign ones and locate attackers. All interns will work as a team and be monitored by a graduate student in the lab at all times to help them clarify concepts and troubleshoot problems during implementation of the system.

Required Skills or Equipment:

High school math knowledge (basic calculus) is sufficient. Basic programming in C or Python is advantageous, but not required due to the simple nature of coding required in this project. We expect students to be able to learn basic programming knowledge during the course of this project.

Expected Outcomes:

Students will learn about practical automotive attacks and how to defend against them. Besides a final poster presentation at the end of the project, students will also deliver the testbed with implemented software and be able to showcase it as a demo. The testbed will be portable and they can present it at other showcases as well. The project will be continued after EUREKA! and successful interns are highly encouraged to continue as undergraduate research interns, potentially as part of Creative Inquiry. The end goal is a publication which interns who continue in their first year at Clemson can be part of. Regardless of continuation, all student interns, as well as the EUREKA! program, will be acknowledged on the publication.

Future Opportunities:

Creative Inquiry will be offered by faculty (CPSC 1990 Automotive Security and Privacy) in the fall. Undergraduate research opportunities are also available. Faculty has extensive experience in undergraduate research, having worked with 18 undergrads at the University of Michigan and 14 at Clemson University (several first-year students). Faculty also highly recommends students to join the CU Cyber student club to learn more about cybersecurity. Faculty is faculty advisor of aforementioned student club.

Research Location:

On-campus in McAdams Hall

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Project Title: Understanding the Experiences of Neurodivergent Learners in Higher Education

Mentor: Matthew Boyer, Research Associate Professor

Department: Engineering & Science Education

Project Description:

Neurodivergent individuals are those who have atypical neurological development, including but not limited to autism, ADHD, dyslexia, and other conditions. While the number of neurodivergent students in higher education is increasing, there is a lack of research on how the university environment impacts their experiences. The goal of this project is to develop a deeper understanding of the experiences of neurodivergent learners in higher education by exploring the following research questions:
What are the challenges that neurodivergent learners face in higher education, and how do they impact their academic performance?
What are the strategies that neurodivergent learners use to overcome these challenges and succeed academically?
What kind of support do neurodivergent learners receive from the university, and how effective is it in helping them succeed?
To answer these questions, the project will use a mixed-methods approach that includes both quantitative and qualitative data. The research methods that will be used include surveys, interviews, and focus groups. The surveys will be used to collect quantitative data on the challenges that neurodivergent learners face and the support they receive. The interviews and focus groups will be used to collect qualitative data on the experiences of neurodivergent learners. This research project will provide a valuable opportunity for the student interns to learn research methods and develop skills in data collection, analysis, and presentation.

Student Involvement:

The research intern(s) will play an essential role in the research project and will be involved in various stages of the research process, specifically:
Literature Review: The research intern(s) will work closely with the project supervisor to conduct a comprehensive review of the existing literature on neurodivergent learners in higher education. This will include searching relevant academic databases, reading and summarizing research articles, and identifying research gaps.
Data Collection: The research intern(s) will assist in the data collection process, which will involve preparing survey questionnaires, conducting interviews, and organizing focus groups. They will also help in the recruitment of participants and scheduling of data collection sessions.

Data Analysis: The research intern(s) will assist in the analysis of both the quantitative and qualitative data. This will involve organizing and cleaning data, running statistical tests, and analyzing the themes and patterns that emerge from the qualitative data.
Poster Presentation: The research intern(s) will work with the project supervisor to develop a poster that summarizes the research findings. They will be responsible for designing the poster layout and contributing to the development of the content.
Overall, the research intern(s) will have the opportunity to develop skills in research methods, data collection, analysis, and presentation. They will receive guidance and support throughout the research process and will be encouraged to participate in regular team meetings to discuss their progress, ask questions, and provide feedback. By the end of the project, the research intern(s) will have gained valuable experience in conducting research and presenting findings at a poster forum.

Required Skills or Equipment:

Strong communication skills: The intern(s) should have excellent oral and written communication skills to communicate effectively with research participants, supervisors, and team members.
Attention to detail: The intern(s) should have excellent attention to detail to ensure that data collection is accurate and complete.
Organizational skills: The intern(s) should have strong organizational skills to manage and prioritize tasks and meet project deadlines.
Proficiency in Microsoft Office and/or Google Apps.
Interest in neurodiversity: The intern(s) should have an interest in neurodiversity and a desire to learn more about the experiences of neurodivergent learners in higher education.
While it is not necessary for the intern(s) to have previous research experience, they should have an interest in research and be willing to learn new skills and techniques throughout the project.

Expected Outcomes:

After the project, the intern(s) will have a deeper understanding of the experiences of neurodivergent learners in higher education. The research findings will contribute to our understanding of the challenges that neurodivergent learners face in higher education and the strategies they use to overcome them. Additionally, the research will provide insight into the kind of support that universities can provide to better meet the needs of neurodivergent learners. The research intern(s) will have the opportunity to develop skills in presenting research findings by creating a poster that summarizes the project's key

findings. They will also have the opportunity to present the poster at a poster forum, where they can share their work with other researchers and university community members. The research intern(s) will have the opportunity to gain experience in research methods, including literature reviews, data collection, data analysis, and presentation development. They will also gain exposure to various research techniques, such as surveys, interviews, and focus groups. The research intern(s) will also have the opportunity to work collaboratively with their supervisor and other team members, allowing them to develop teamwork and collaboration skills.

Future Opportunities:

Future opportunities for collaboration with Dr. Boyer and his graduate students on this line of research and development will be available to students after completion of the project. Participating in a research experience is an impressive addition to any resume, as it demonstrates the student's dedication to their field and ability to conduct independent research. Research experiences provide opportunities for students to network with other researchers, professors, and professionals in their field. These connections can be valuable for career development and may lead to future research opportunities. If the research findings are significant, students may have opportunities to publish their work in academic journals or present at conferences. This can be a valuable addition to their resume and help them establish themselves as emerging experts in their field. Research experiences also require students to analyze complex data and draw conclusions based on evidence. This can help students develop critical thinking and problem-solving skills that are valuable in any career path.

Research Location:

On-campus in Riggs Hall

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Project Title: Sustainability: Techno-Economic Assessment of Solar PV System

Mentor: Michael Carbajales-Dale, Assistant Professor

Department: Environmental Engineering and Earth Sciences

Project Description:

The goal of the project is to conduct a technical design and economic assessment of the viability of commercial solar photovoltaic system in the far South.

Student Involvement:

The research student will work with us in the Solar PV system sizing and modeling. They will learn how to design a solar PV system using software.

Required Skills or Equipment:

Students should be proficient in statistics and possess knowledge or interest in learning about software modeling. The lab will purchase the required PVsyst software license for students upon arrival.

Expected Outcomes:

At the end of the project, students will have learned new software, reviewed literature papers, analyzed data, and researched presentations.

Future Opportunities:

The students would be welcome to continue working with the research group on similar sustainability projects, specifically life cycle assessments.

Research Location:

On-campus in Brackett Hall

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Project Title: Electrification of Water Treatment Processes for Resource Recovery

Mentor: Sudeep Popat, Associate Professor

Department: Environmental Engineering and Earth Sciences

Project Description:

The project uses electrochemical techniques to produce chemical in situ in wastewater streams to result in treatment and/or resource recovery. This year, we will focus on electrochemical production of hydrogen peroxide and hydroxide ions in situ in source-separated urine to stabilize urea and/or recover struvite. Urea and struvite are fertilizers which otherwise need large amounts of energy to produce and result in significant greenhouse gas emissions. By recovering these directly from source-separated urine, we can recycle nitrogen and phosphorus. Applications include incorporating such electrified technologies within new infrastructure, but such developments could also help sanitation in developing countries as well as life support systems for space missions.

Student Involvement:

The research intern will work closely with a graduate student in performining experiments, collecting samples, performing chemical analyses of samples collected, and analyzing and interpreting data collected.

Required Skills or Equipment:

Selected students should be interested in chemistry, chemical engineering and/or environmental engineering. Prior laboratory experience in chemistry is preferred. Students should also have background in using Excel to plot charts.

Expected Outcomes:

The students will be able to present a poster, and also be part of a larger study, which is likely lead to presentations at national conferences and/or publications in peer-reviewed journals.

Future Opportunities:

We regularly host students through the Palmetto Academy program to perform research on such topics.

Research Location:

Off-campus at the Rich Laboratory in Anderson, SC

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Project Title: The Molecular Response of Poplar to Sphaerulina musiva, a Fungal Pathogen

Mentor: Haiying Liang, Associate Professor

Department: Genetics and Biochemistry

Project Description:

Poplar is an important woody species for pulping, furniture, and bioenergy. And Sphaerulina musiva is a damaging pathogen that can cause leaf spot and canker diseases. The ultimate goal of the project is to understand the molecular mechanisms underpinning the resistance and susceptibility in the host.

Student Involvement:

Students will assist with poplar transformation with Rapid alkalization factor-like (RALFL) genes. They will also be performing quantitative reverse transcription PCR (RT-qPCR) to investigate the spatial expression of poplar RAFL genes. The intern will be teamed up with graduate students in the lab to assist with the research.

Required Skills or Equipment:

None

Expected Outcomes:

Students will create a presentation when the program ends.

Future Opportunities:

The student can continue the research in the fall and potentially co-author a manuscript to publish the research findings.

Research Location:

On-campus

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Project Title: Biotechnology - Crop Genetic Engineering for Enhanced Agriculral Production

Mentor: Hong Luo, Professor

Department: Genetics and Biochemistry

Project Description:

Environmental stress is one of the most important factors impacting agriculture production. Plant genetic engineering using molecular cloning and transgenic approaches has been playing an increasingly important role in modern agriculture. Development of novel molecular strategies to genetically engineer important crops will lead to new cultivars with beneficial new traits, enhancing crop yield. This project focuses on manipulation of expression of several stress-related candidate genes in transgenic rice and turfgrass plants to achieve enhanced plant performance under adverse environmental conditions such as drought and salt stress, improving agriculture production and economy. For those participating in the proposed project online, a series of online PowerPoint presentations and literature reading and discussion sessions will be organized thoroughly introducing to the students the principles of gene cloning, biotechnology approaches for plant genetic engineering and transgenic analysis to evaluate improved crop performance under adverse environmental conditions. Those participating in the proposed project in-person will work with graduate students to learn and gain hands-on experience in gene cloning, chimeric gene construction, plant genetic transformation and transgenic analysis.

Student Involvement:

The students participating in the project online will read and discuss related research papers on plant molecular biology, plant genetic engineering and molecular mechanisms of plant-environment interaction. They will participate in all the online presentations and discussions, and actively interact with myself, graduate students and the post-doc researcher to become familiar with the basics about scientific research, gene cloning, gene functional characterization and chimeric gene construction as well as plant genetic transformation and transgenic analysis. The students participating in the proposed project in-person will work with graduate students to learn and gain hands-on experience in gene cloning, chimeric gene construction, plant genetic transformation and transgenic analysis.

Required Skills or Equipment:

No specific skills are required for the students to be involved in this project. Knowledge learned from high school biology courses will be enough to participate in the project. The students will be trained to learn basic molecular and cell biology

techniques including DNA and RNA extraction, DNA cloning, plasmid construction, PCR, plant tissue culture and plant genetic transformation.

Expected Outcomes:

The project would allow students to become familiar with the basics about scientific research, gene cloning, gene functional characterization and chimeric gene construction as well as plant genetic transformation and transgenic analysis. They will also be trained to read scientific literature as well as to prepare, present, communicate and discuss scientific data to their peers and general public.

Future Opportunities:

The students could continue their research in the lab and gain more hands-on research experience and have opportunities to present research data in professional meetings and publish their discoveries. This experience has been very helpful for many students in their application for graduate school, medical school and other professional opportunities.

Research Location:

On-campus

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Project Title: DNA Repair and Genome Instability

Mentor: Michael Sehorn, Associate Professor

Department: Genetics and Biochemistry

Project Description:

The overall aim of the project is to understand the biochemical mechanism by which DNA repair proteins function in genome stability. This involves cloning of DNA repair genes and using PCR to introduce mutations into these DNA repair genes. The mutations that we insert into these genes provide a way to understand how the mutation affects the activity of the DNA repair protein. The student will also express the protein in order to purify it. Once the protein is purified, the intern will biochemically characterize the protein for DNA binding activity, protein-protein interactions and functional DNA repair assays. This project will provide valuable insight into the role these DNA repair genes play in maintaining genome stability.

Student Involvement:

The intern will perform the actual experiments (PCR, agarose gel electrophoresis, SDS-PAGE gel electrophoresis, protein expression, etc.). The student will be guided by graduate students, undergraduate students and the professor. Each person in the lab has their own projects but they recruit other students and interns to help them complete the work for the project. Therefore, the individual activities performed by each person serve to help the collective of the lab to be successful.

Required Skills or Equipment:

The intern is not required to have any skills, experiences or knowledge of this project. We will train the intern to do the experiments they will conduct for their project. We find this helps build confidence for the intern in their newfound abilities.

Expected Outcomes:

Within the time frame of the EUREKA! program, the intern will be able to generate data that is appropriate for the poster session. The end goal of the project is to produce data that would be published in a peer-reviewed journal.

Future Opportunities:

At the end of the EUREKA! program, the intern will have the opportunity to continue in the lab for the duration of their time at Clemson should that be something they want to do.

Research Location:

On-campus

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Project Title: AI in Biomedicine: Prediction of Novel Human Disease Genes by Genomic Data Mining

Mentor: Liangjiang (LJ) Wang, Associate Professor

Department: Genetics and Biochemistry

Project Description:

In the human genome, most genes actually do not encode proteins; they are non-coding RNA genes. The largest class of non-coding genes is known as long non-coding RNAs (lncRNAs), which are transcripts greater in length than 200 nucleotides, but with no protein-coding capacity. While some lncRNAs have been demonstrated to be key regulators of gene expression and 3D genome organization, most lncRNAs are still uncharacterized. We have thus been developing artificial intelligence (AI) and machine learning approaches for the functional annotation of human lncRNAs through mining the vast amount of genetic and genomic data ("biological big data"). Our recent studies demonstrate that genomic data mining can give insights into RNA functions and provide valuable information for experimental studies of candidate lncRNAs.

This research project will focus on the identification and functional analysis of novel candidate lncRNAs associated with human diseases, including autism spectrum disorders (ASD) and intellectual disability (ID). ASD and ID are clinically and genetically heterogeneous complex disorders, affecting up to 1% and 3% of the human population, respectively. ASD is characterized by impaired social communications and restrictive or repetitive behavior, whereas ID is recognized by diminished intellectual capacity and adaptive reasoning. Both disorders originate in early childhood, and involve a large number of genes essential for normal brain development and function. However, in most cases of ASD or ID, the specific genetic factors of the disorders are still unable to be determined. Until recently, only protein-coding genes were studied for their involvement in ASD and ID. It is thus likely that many of these disease-causing genetic factors may reside in lncRNAs, which are enriched in the brain. The research interns will learn how to build machine learning models for candidate disease gene prediction, and then utilize publicly available genetic and genomic data to further characterize and prioritize the candidate lncRNAs. The high-priority candidates identified in this project can not only provide new insight into the roles of lncRNAs in genetic brain disorders, but may also be further developed as biomarkers.

Student Involvement:

Research interns will be directly involved in the project. Each intern student, under the supervision of a graduate student, will learn how to build a machine learning model for candidate disease gene prediction and prioritization. They will also contribute to the further evaluation and curation of novel candidate lncRNAs associated with genetic brain disorders.

Required Skills or Equipment:

Research interns are expected to have good computer skills and understand the basic concepts of genetics. Although prior experience with computational research is not required, the interns are expected to be willing to learn basic AI/machine learning concepts and computer programming skills for genomic data mining.

Expected Outcomes:

The project will generate a prioritized list of candidate lncRNAs associated with genetic brain disorders. The findings can be used for presentations and journal publications. The intern students will also learn large-scale genomic data analysis and use of AI/machine learning techniques in biomedical research.

Future Opportunities:

The data analysis skills learned through this project can be useful for future careers in biomedical data science, bioinformatics, genomics, human genetics, and precision medicine.

Research Location:

On-campus in the Life Science Facility

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Project Title: Computational Materials Science Coupled with Data Science for the Design of Multi-Principal Element Alloys

Mentor: Dilpuneet Aidhy, Associate Professor

Department: Materials Science and Engineering

Project Description:

The presence of multiple elements in large proportions in HEAs opens a vast compositional phase space with exciting materials design opportunities. However, it also presents a large computational challenge to the design and discovery of materials, especially for density functional theory (DFT), which has traditionally been highly successful in the design of conventional/dilute materials. Additionally, the random presence of chemically-different elements on a crystal lattice presents rich physics but also creates electronic and lattice distortions essentially at each lattice site thereby creating additional challenge to understand the mechanisms that lead to the exciting properties. At MCDC, we are developing data science methods to enable predictions of HEA properties. The students will couple data science with DFT to learn atomic level patterns for predicting properties in HEAs.

Student Involvement:

The undergraduate students will learn the materials science of high entropy alloys (HEAs), train on performing atomic level simulations, learn python-based coding and data science methods for predicting materials properties. The students will work with graduate students in Dr. Aidhy's Materials Computation and Data Science (MCDC) Laboratory and leverage existing tools. The students will work with the advisor, postdoc and graduate students. They will learn to approach a scientific problem, design a method to solving the challenge and develop analytically skills to analyze their data in a meaningful scientific manner. More importantly, they will learn the scientific environment and ethics of conducting research. The students will regularly discuss their work with the group members and present at weekly group meetings. They will learn data science skills and materials science knowledge.

Required Skills or Equipment:

Students should possess beginner coding knowledge such as in Excel. We will teach coding in python and Jupyter notebooks. Students should have also completed basic chemistry in high school.

Expected Outcomes:

The students will be able to code in python, conduct atomic level simulations and perform analysis of their data. An ambitious student would be able to develop machine learning codes. They could end up as a co-author in a peer-reviewed publication. If interested, I will provide them funding to continue to work in our group as they progress at Clemson.

Future Opportunities:

Students will be able to work as a regular undergraduate research students in my group for their 4 years. The students may also get opportunities to present at local and national conferences and possibly publish their work in peer-reviewed journals. This platform will contribute to future workforce at the intersection of computational materials and data sciences. I will try to send them to DOE National Labs via the SULI internship program to gain further experience.
https://science.osti.gov/wdts/suli

Research Location:

On-campus

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Project Title: Not All Cellulose is Made the Same... Plant Cellulose vs. Bacterial Cellulose, Which One is More Sustainable?

Mentor: Rodrigo Martinez-Duarte, Associate Professor

Department: Mechanical Engineering

Project Description:

Bacterial cellulose (BC) is a fantastic biomaterial that is rapidly gaining ground as an engineering material. BC can be grown pure in a bioreactor and features better mechanical properties than cellulose purified from plants. Indeed, BC shows much potential as is, forming composites, or serving as a precursor for carbon-based materials. As such, examples of application range from wound healing to carbonaceous electrodes in energy components. While BC does not require forest management and the purification of cellulose from lignin and hemicellulose, it does require controlled conditions in a bioreactor and specific growth media. This project is about comparing the sustainability of cellulose derived from bacteria and that derived from plants. There are multiple ways to produce one or the other and you and your team will be first assessing these to compare them later. To this end, you will be using SimaPro, a commercial software, to analyze the life cycle of both kinds of cellulose. The hypothesis is that BC compares advantageously to plant cellulose in terms of energy required and environmental impact, and that is what we will start testing. In collaboration, we will be exploring the context of this problem and framing the important questions that further enable the understanding of the true cost and impact of growing BC compared to harvesting plant cellulose.

Student Involvement:

You will be working in a team-oriented lab environment that includes both undergraduate and graduate researchers. The lab is goal oriented and as such you will be given a goal to accomplish by the end of your tenure (comparing the life cycle analysis of both types of cellulose). In collaboration with the principal investigator (PI), you will learn to break up the project into smaller goals to be accomplished each week and confirmed during the weekly meeting with the PI.

Required Skills or Equipment:

You must be curious, comfortable with ill-defined problems, and strongly willing to pull threads in multiple areas. Above all, you must be excited to come to work and craving to engage with the team. Experience analyzing scientific literature is desired but not required. The license to SimaPro will be provided. Students must have VPN installed if not on-campus.

Expected Outcomes:

You will learn how to do a life cycle analysis of a product and its process. You will also learn how to develop a research plan with a goal in mind. At the very least, an abstract should be submitted to a conference. A manuscript to be sent for publication would be ideal. Most importantly, this project will enable the student to get a significant head start on the research opportunities available in the group.

Future Opportunities:

The lab has a strong record of undergraduate research that brings diverse majors together in a team within the Creative Inquiry framework. Creative Inquiry and Honors research opportunities will be available.

Research Location:

On-campus in the Flour Daniel Building

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Project Title: Computational Cardiovascular Research

Mentor: Ethan Kung, Associate Professor

Department: Mechanical Engineering and Bioengineering

Project Description:

In this project, students will use computational methods to help solve clinical problems related to the cardiovascular field. This may include simulations to model the cardiovascular system, potentially constructing patient-specific models, and analysis of clinical database to identify trends and regression models. The project may extend to computational modeling of related medical devices. For Summer 2023, the research will involve building 3D anatomic models and performing computational fluid dynamic simulations of carotid bifurcation from patient imaging data.

Student Involvement:

Students will learn how to use new software to perform computer simulations and data analyses to answer scientific or clinical questions. This Summer the research will be addressing the particular question "How do we determine whether a patient with asymptomatic carotid stenosis needs to be treated?" The computational models that we employ will be 3D finite element models, and Excel or Matlab based data analysis and regression modeling.

Required Skills or Equipment:

Students must have the ability to learn to use new engineering software and hardware as well as be able to learn basic data processing and coding in Matlab. The ability to grasp new scientific concepts is also helpful.

Expected Outcomes:

Students will learn how to construct 3D geometric models from patient imaging data, setup computational fluid dynamic simulations, and perform statistical data analysis such as T-test and regression.

Future Opportunities:

After the program, students will have the opportunity to continue related research in Creative Inquiry or summer research.

Research Location:

On-campus in Daniel Building

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Project Title: Project SUNDAYS: Engaging Rural African American Religious and Spiritual Leaders on Advance Care Planning

Mentor: Tracy Fasolino, Professor

Department: Nursing

Project Description:

Project SUNDAYS focuses on the rural minority disparities of Black/African American (AA) seriously ill patients. Our three measurable goals are: 1) assessing the religious/spiritual beliefs, values, and preferences toward advance care planning (ACP) conversations and directives by Christian Black/AA faith leader(s) serving in rural South Carolina (SC), 2) creating an evaluation tool to assess current ACP training modules (two modules and resources available through the Center to Advance Palliative Care - CAPC), and 3) evaluating current ACP training modules to determine how they align with beliefs of Christian Black/AA faith leader(s). The outcomes of Phase I include a holistic understanding of rural Christian Black/AA faith leader(s) position on ACP conversations, including the current barriers and facilitators as well as theological underpinning.

Student Involvement:

By the beginning of EUREKA!, the existing research team will have completed a number of the 12 interviews planned with faith leaders in rural communities. Several of these transcripts will need to be reviewed, edited to remove any identifying information, and cleaned for robust data analysis (Estimated 10 hours of transcripts). With this activity, the students will learn about the importance of interviewing techniques, the value of rich narrative stories, and the impact of faith leaders on advance care planning/serious illness conversations. We will work collectively to load the transcripts into NVivo (qualitative data analysis computer software package produced by QSR International). The students will learn how to use this software to process qualitative data to discover common themes, etc.

Required Skills or Equipment:

Students posing a sense of curiosity would be ideal for this project. We are focusing on Christian theology and faith (Judaism) so students would want to be comfortable with this religious focus. We have much to learn about the impact of our religious/spiritual leaders in rural AA/Black communities on serious illness conversations. Students should be comfortable with Microsoft software (Word, PowerPoint, and Publisher). Students should also be comfortable learning of and talking about Christian faith.

Expected Outcomes:

An expected outcome of this project is designing, creating, and disseminating a scholarly podium presentation/poster to be delivered to the current Project SUNDAYS research team. The students will gain experience working with transcripts (qualitative data) and the use of program software (NVivo) to organize, analyze, and find insights into unstructured data. Additionally, they will gain experience working in an interdisciplinary team of researchers, educators, and clinicians.

Future Opportunities:

Students will have the opportunity to share their work at regional and state level proceedings. For example, the South Carolina Society of Chaplains have quarterly meetings so students could present the findings from the qualitative analysis. As the project moves forward, students will have the option of joining a Creative Inquiry team to continue working on the project. Ultimately, the goal will be for students to participant in scholarly writing for a journal article in the American Journal of Hospice & Palliative Care. Impact Factor: 2.090 / 5-Year Impact Factor: 2.379.

Research Location:

On-campus

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Project Title: The Effects of Mediterranean Herb Extracts on Breast Cancer Cells and Assessment of their Metabolic Profiles

Mentor: Diana Ivankovic, Professor

Department: Nursing

Project Description:

We use a specific method, called microwave extraction, to obtain Mediterranean herb compounds. We then expose primary and metastatic breast cancer cells to them. We perform a live/dead assay, called MTS, to assess their viability, and the anticarcinogenic potential of these extracts. Lastly, we use the Biolog machines to assess their metabolic profiles.

Student Involvement:

We will train our research students in person, as well as provide safety courses online. The students will first shadow us, and then, slowly, we will let them do hands-on activities such as feeding, splitting, and counting cells. Students will also be exposed to various herbal extracts and learn to analyze their metabolic activity over time.

Required Skills or Equipment:

The interns just need to be attentive, take good notes, and learn from their mistakes. No specific knowledge is needed, coming into our lab.

Expected Outcomes:

They will present their findings in a poster format. If they so proficiency at research, we will offer them a position to continue conducting research in our lab. In doing so, the students will get published and go to conferences with us. Two of our EUREKA! students form last year are going to the Ernest Just Symposium with us at MUSC. All of our EUREKA! students from last year chose to stay with us and they have now been doing research in our lab for two semesters.

Future Opportunities:

The students might get chosen to stay in our lab, and continue doing research and get credit hours.

Research Location:

On-campus in Edwards Hall

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Project Title: Facilitators and Barriers to Using Telepresence Robots in Healthcare Settings

Mentor: Janice Lanham, Principal Lecturer

Department: Nursing

Project Description:

The use of robotic assistance may help enhance the delivery of quality patient care. Although telepresence robots have been used in healthcare settings, a comprehensive review of studies focusing on their use requires further investigation. This project will focus on the use of telepresence robots to support and facilitate patient care in acute care settings. Project results will provide a summary of evidence about the facilitators and barriers to the use of telepresence robots in healthcare.

Student Involvement:

The students will assist with research including conducting a comprehensive literature review using the following databases: MEDLINE (Ovid), CINAHL, PsycINFO (EBSCO), Web of Science and ProQuest Dissertations & Theses Global. Google and Google Scholar will be used to search for additional literature. A handsearch will be conducted using the reference lists of included studies to identify additional relevant articles.

Required Skills or Equipment:

None

Expected Outcomes:

Upon project completion, the student intern will be able to outline steps in the research process and become familiar with the Double (Telepresence) Robot, e.g. operations, features, tech specifications, etc.

Future Opportunities:

Students will be able to continue this work as a Creative Inquiry for academic credit. They will also be able to create a poster or oral presentations at local, state, regional or national conferences.

Research Location:

On-campus in Edwards Hall

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Project Title: Understanding Seasonal Nutrient Uptake of Fruit Trees

Mentor: Juan Carlos Melgar, Associate Professor

Department: Plant and Environmental Sciences

Project Description:

Nutrients such as nitrogen or potassium influence the productivity of fruit orchards and are annually applied to the soil to maintain tree nutritional status. Fruit growers typically fertilize trees twice a year (split-fertilization): in spring (bloom time) and in summer (after harvest). Nevertheless, it is not known how factors such as soil temperature affect root nutrient acquisition. High temperatures are thought to reduce root nutrient uptake and, in that case, postharvest fertilization would be much less efficient, leading to nutrient loss and underground soil and water pollution. The goal of this project is to determine the influence of soil temperature on nutrient absorption throughout early and mid-summer and, thus, the efficiency of postharvest fertilization. We will use labeled nutrients (injected in the soil), and perform leaf analysis to measure when and at which concentrations they appear in leaves so that we can determine nutrient use efficiency.

Student Involvement:

The research intern will be involved in all steps of the study: nutrient injection in the field (there will be four; one per week for a month), leaf analysis in the lab, data analysis, and presentations of results at a regional conference in fall. At all these steps, the intern will work together with the faculty (Dr. Melgar) and other graduate/undergraduate students. In our lab, we work as a team, and everyone helps each other.

Required Skills or Equipment:

No previous experience in research is needed, although knowledge of general biology and chemistry is important. Everything else, from lab techniques to statistical analysis can be learned (every year we have undergraduate students that come to the lab with zero previous experiences and they succeed at completing their projects). Students should bring a hat for the days we go to the field at the Musser Fruit Research Farm. We go in the morning to avoid the heat of the day and always try to be back in the lab by around 10 am, but many mornings are hot in South Carolina. A driver's license is not needed; Dr. Melgar will drive with the intern to the field in a state vehicle (15 minutes from Clemson).

Expected Outcomes:

Other than the presentation required for the EUREKA! program, we will encourage the student to come to the Southeastern Professional Fruit Workers Conference, which is a conference where undergraduate and graduate students, as well as researchers working on fruit trees present their research. It will take place in the fall in Auburn, AL. The whole lab group will attend. If results are publishable, we will definitely want to publish them.

Future Opportunities:

During their research experience, the students will be able to learn about the research work of three graduate students. Other than attending and presenting at the conference, undergraduate students are always welcome to continue in the lab as part-time workers if they want to continue doing undergraduate research.

Research Location:

Off-campus at the Musser Fruit Research Farm in Seneca, SC

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Project Title: Climate Resilient Crops for Food Security

Mentor: Sruthi Narayanan, Associate Professor

Department: Plant and Environmental Sciences

Project Description:

Our crop-ecophysiological research program focuses on improving productivity of agronomic crops through economically viable and environmentally sustainable agronomic practices. Climate variability necessitates the development of resilient, regionally adapted production systems and our group strives to achieve this by applying concepts from physiology, biochemistry, lipidomics, and genomics. We study crop response and adaptation to changing environmental conditions (water and temperature) in order to develop climate resilient crop varieties. Crop-ecophysiological responses from the rhizosphere to the global scale are studied using on-farm, greenhouse, growth chamber, laboratory, and modeling experiments.

Student Involvement:

The EUREKA! students can take part in multiple projects within our lab.

1. Improve soybean's efficiency for heat tolerance with an integrated metabolic and genetic approach: We aim to identify soybean genes associated with lipid metabolic changes and with physiological mechanisms contributing to heat tolerance and to develop molecular markers for high-throughput screening of large germplasm collections for heat tolerance.
2. Identify molecular markers associated with root traits that improve performance in cotton: We will work to characterize the US Upland Cotton Core Set of allelic richness for root traits, water use efficiency, and yield and correlate the root phenotypic information with the existing genotypic information of the Core Set to identify molecular markers associated with root traits that improve water use efficiency and yield of cotton.
3. Identification of molecular markers for breeding for heat tolerance in peanut: The objective of this project is to evaluate the heat tolerance of the F8 population of 74 peanut lines (derived from a cross between a heat-tolerant genotype and heat susceptible genotype) based on physiological traits related to lipid metabolism and membrane stability.
4. Cover crop inter-seeding in organic corn production to reduce resource inputs and soil disturbance and enhance pest control and farm profitability: Our goal is to evaluate different cover crops (white clover, buck wheat, pigeon pea, and their mixture) inter-seeded with corn at multiple seeding rates and under conventionally tilled or no-tilled conditions to identify cover crops and their management practices that alleviate soil compaction, suppress weed infestation, and enhance microbial communities that improve nutrient availability and soil health.

Required Skills or Equipment:

Students should possess a passion for plant science, ability to work as a team, and basic computer and software skills.

Expected Outcomes:

The student will learn research methods common to any crop science research program. This will prepare them for future undergraduate research and graduate school. If the student continues to work on the research project in the Fall, he/she might get an opportunity to present their research in the Crop Science Society of America annual meeting. Depending upon the contributions, the student may get a co-authorship in the publication.

Future Opportunities:

Students will get an opportunity to continue research in our lab (depending upon their performance in the summer). In the long run, there is a potential opportunity for a graduate research assistantship, if the student demonstrates potential for a researcher.

Research Location:

Off-campus at the Piedmont REC in Pendleton, SC

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Project Title: Elucidating the Effect of Plant Chemistry on Soil Carbon Chemistry

Mentor: Vidya Suseela, Assistant Professor

Department: Plant and Environmental Sciences

Project Description:

Soils, due to their capacity to store vast quantities of carbon, can help mitigate climate change and enhance sustainable food production. Soil organic carbon (SOC) allows soils to perform these functions as it improves nutrient and water retention and enhances soil biological health. Soils in many ecosystems are depleted in SOC due to intensive management practices. Plants are a major pathway through which atmospheric carbon can be channeled to SOC via the microbial decomposition of the shoot and root tissues. SOC is highly heterogenous, with a multitude of biomolecules resulting from the decomposition of plant and microbial biomass that can be sequestered in different soil fractions. The research in the proposed project will evaluate how plant tissue type (root vs. leaf) and plant functional type identity (eg; grass, legume) affect dissolved organic matter formation and chemical composition and, in turn, the interaction of these plant factors with microbial parameters and soil mineralogy in influencing SOC formation.

Student Involvement:

The research interns will process plant samples for wet chemistry and instrument analysis. The interns will get hands on experience in analytical techniques such as GC/LC-MS/MS, wet chemistry analyses and mycorrhizal analyses. The interns will also get an opportunity to participate in manuscript preparation including data processing using statistical softwares, preparation of graphs using standard softwares such as sigmaplot and interpretation of results.

Required Skills or Equipment:

We prefer interns who are majoring in Biological Sciences, Chemistry, Genetics & Biochemistry, or any Life Science discipline. Some general experience with working in laboratory settings is preferred.

Expected Outcomes:

Expected outcomes also include authorship in peer reviewed publication, authorship in abstracts submitted to national meetings such as Ecological Society of America (ESA) or American Geophysical Union (AGU), and the opportunity to present at these national meetings.

Future Opportunities:

These projects are part of a larger NSF and USDA funded projects in Suseela lab. The interns have ample opportunity to continue working in these larger projects. The lab also has other projects on plant mycorrhizal symbiosis, soil nutrient cycling, and utilizing soil microbiome in imparting drought tolerance to plants, in which the interns can participate if interested. They can also pursue an Honors thesis in these projects or get credit for course work. Our lab also has paid internship opportunities after the summer which are offered based on the satisfactory performance of the interns. Interns who are interested in pursuing graduate studies will also be mentored in developing and writing proposals for National Science Foundation Graduate Fellowship program.

Research Location:

On-campus in the Biosystems Research Complex

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Project Title: Attitudes Toward Advanced Vehicle Technologies

Mentor: Dustin Souders, Assistant Professor

Department: Psychology

Project Description:

Society at large stands to benefit from vehicle technologies that are here (e.g., advanced driver assistance systems; ADAS) as well as those that are likely to be broadly available in the next few years automated vehicles (AVs). As suggested by the current availability of ADAS and the yet-to-be-delivered AV technologies these attitudes can be grounded in real-world experiences or the beliefs and projections the individual holds. This project gives the EUREKA! student experience evaluating both, as part of a team conducting a driving simulator study on attitudes toward different driver monitoring system approaches that govern the use of highly automated ADAS available today, as well as individual experience cleaning and analyzing a dataset on attitudes toward advanced vehicle technologies held by individuals with varying levels of disability.

Student Involvement:

This project will seek to answer questions about the relationship between disability and attitudes towards these advanced vehicle technologies and involve the EUREKA! student in two ways: 1.) Individual involvement in conducting a secondary analysis of a dataset collected by Partners for Automated Vehicle Education (PAVE) on this subject, and 2.) Involvement as a lab assistant in designing and deploying a driving simulator study on attitudes toward different driver monitoring system (DMS) approaches that are being deployed in ADAS-equipped vehicles that are available to the public today.

Required Skills or Equipment:

Some familiarity with cleaning datasets and performing statistical analyses would be beneficial, but would not be required and can be learned as a part of the project.

Expected Outcomes:

Both prongs of the EUREKA! student's involvement will eventually lead to publications and presentations, though one is attainable by the end of the EUREKA! program while the other is less likely to be completed by then. Both will afford the student greater familiarity with statistical software such as R or SPSS. The individual PAVE dataset analysis (attainable by the end of the program), the student will learn valuable skills in handling and cleaning pre-existing data and statistically analyzing it using R or SPSS to uncover what insights it might hold. With the team-based involvement in assisting with the driving

simulator study, the student will learn what is involved in conducting technologically advanced human subjects data collection as part of a team and gain familiarity with data collection using eye tracking and driving simulation software and hardware.

Future Opportunities:

Continued involvement with my lab's CI team and/or the ability to conduct follow-up research via an Honors thesis would naturally follow, provided the experience goes well for all parties. The ability to present the research at international conferences is also a possibility, as is co-authorship on resulting manuscripts from the research.

Research Location:

On-campus in Brackett Hall

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