2024 Online EUREKA! Project List

The following table contains the projects available for the 2024 Online EUREKA! Program. Project details are available on the pages following this table. The "Project Title" in this table will hyperlink you to the project information. The "Project Title" on the later pages will hyperlink you to the project or mentor website. The "Department" on the later pages will hyperlink you to the department's website. If you do not see a project or department that interests you, you will have the option to suggest one on your application. All students participating in the Online EUREKA! Program must have a computer with a camera and microphone, a strong internet connection, and access to Zoom and Microsoft Teams. Please email us at eureka@clemson.edu with any questions.

Department	Project Title
Agricultural Sciences	Surveys of Agricultural Producers and their Adoption of Climate-Smart Practices
Animal and Veterinary Sciences	Grazing Cover Crops to Enhance Forage Production, Quality and Sustainability of Forage-Livestock Systems
Automotive Engineering	Driving Safety and Intelligent Vehicles
Automotive Engineering	OpenCAV
Biological Sciences	Drug-induced Cardiovascular Toxicity and Mitochondrial Dysfunction
Civil Engineering	Bio-inspired Drilling into Lunar Regolith
Computing	How to Build a Large Language Model (From Scratch)
Computing	Ensuring Privacy Compliance in Software Development
Computing	Machine Learning-based 3D Reconstruction
Electrical and Computer Engineering	Adaptive Multi-Tiered, Multi-Task Base Station Infrastructure For Communication-Denied Environments
Electrical and Computer Engineering	Exploring Security Threats to the Use of Smartphones
Electrical and Computer Engineering	Evaluation of Large Language Models
Engineering & Science Education	Understanding the Experiences of Neurodivergent Learners in Higher Education
Food, Nutrition and Packaging Sciences	Understanding of Retort Processing for Food Safety and Shelf Life of Food Products

(continued on next page)

Department	Project Title
Genetics and Biochemistry	AI in Biomedicine: Prediction of Novel Human Disease Genes by Genomic Data Mining
Genetics and Biochemistry	Plant Biotechnology for Enhanced Agricultural Production
Genetics and Biochemistry	Gene Expression During Cyst Formation in the Human Parasite Entamoeba histolytica
Languages/Interdisciplinary Studies	Thomas Green Clemson in Paris: 1826-1831
Marketing	Using Machine Learning to Automate the Assessment of Creative and Entrepreneurial Personality
Mathematical and Statistical Sciences	Train Neural Networks to Emulate Waves
Mechanical Engineering	Bioinspired Structural Materials by Design
Mechanical Engineering	Not all cellulose is made the same… Plant Cellulose vs. Bacterial Cellulose, which one is more Sustainable?
Mechanical Engineering / Bioengineering	Experimental and Computational Cardiovascular Research
Sociology, Anthropology and Criminal Justice	A Pilot Study of Undergraduate Students Major Change Behaviors
Teaching and Learning	Seeing the Bigger Picture: Analyzing Body Size Representation in Picturebooks

Project Title: Surveys of Agricultural Producers and their Adoption of Climate-Smart Practices
Mentor: Anastasia Thayer, Assistant Professor
Department: Agricultural Sciences

Project Description:

Climate-Smart Grown in SC is a large multi-year, multi-institution effort funded by the United States Department of Agriculture to increase adoption of climate-smart agricultural practices on leafy green, peanut, and cattle farms across South Carolina. As part of this large multi-disciplinary effort, researchers on the market development team are working to understand adoption decisions, costs and benefits of adoption, and potential market opportunities. In summer 2024, the team will be surveying enrolled producers after their first year enrolled in the program to gather information about their operation and learn more about practice adoption.

Student Involvement:

Interns this year will work with the market development agricultural team to create three survey instruments to be deployed to agricultural producers involved in the project. The survey will focus on questions related to climate-smart practices, adoption challenges, costs and benefits of adoption, product marketing, and other related economic and business questions. As time allows, interns will have the opportunity to manage and clean response data as well as prepare and disseminate findings.

In addition to the technical aspects of the project, interns will be introduced to the team and work with the project team. This will provide exposure to interdisciplinary, team-based research.

Required Skills / Prerequisites:

No prior experience or skills needed. Knowledge of and/or interest of agriculture is helpful but not required.

Expected Outcomes:

Interns will be directly involved with creation and deployment of the survey instrument. Depending on student interest and time, students could also be working with data produced from the survey and have an opportunity to assist in dissemination of results.

Future Opportunities:

The Climate-Smart Grown in SC project is a large multi-disciplinary, multi-year project. With this in mind, students could use this internship as a way to learn more about the project, other associated researchers, and leverage this opportunity to find or create other undergraduate research opportunities.

Back to Index

Project Title: Grazing Cover Crops to Enhance Forage Production, Quality and Sustainability of Forage-Livestock Systems

Mentor: Liliane Silva, Assistant Professor

Department: Animal and Veterinary Sciences

Project Description:

Cover crops are a viable option to provide forage production for livestock while supporting ecosystem services, reducing soil and nutrient losses, and improving soil fertility, among others. There is a growing use of cover crops in rotation with different crop production systems, besides their use as winter grazing in livestock operations. In this context, understanding the roles that cover crops play in supporting biomass production and delivering ecosystem services helps to properly design management practices that can support the optimization of their use and the production, profitability, and sustainability of agricultural operations.

Student Involvement:

The student intern will conduct individual readings in addition to weekly discussions about the topic, then, will outline and develop a written piece to be published on Clemson blogs. The student intern will also work on a small research dataset from a grazing cover crops trial and will be responsible for collecting additional demographics and other data to illustrate the use and the importance of cover crops in SC and the Southeast region in agricultural settings, particularly in livestock operations.

Required Skills / Prerequisites:

Students must have basic Word skills. The intern will also be trained to use PowerPoint and Excel. It would also be helpful to know some general understanding of agricultural systems.

Expected Outcomes:

The expectation is for the intern to develop a written piece to be published on Clemson blogs. The student intern will gain knowledge about forage and animal production in South Carolina and the Southeast, will learn to generate basic graphics through data interpretation and outline Extension related publications, among others.

Future Opportunities:

The goal is to develop a written piece to be published through the Clemson blogs during the internship. If the intern is interested in further experience, Dr. Silva conducts research and Extension activities, and the student intern could continue the internship later on to gain experience in one of those areas.

Back to Index

Project Title: Driving Safety and Intelligent Vehicles
Mentor: Bing Li, Assistant Professor
Department: Automotive Engineering

Project Description:

The interns will explore artificial intelligence, ChatGPT and existing technologies for intelligent vehicles and driving safety.

Student Involvement:

The interns will conduct surveys, might run programs, and write reports.

Required Skills / Prerequisites:

Python or alternative-language programming skills are preferred, but not required. Students should be interested in driving safety.

Expected Outcomes:

Students will create a presentation and report as well as have the opportunity to develop software.

Future Opportunities:

The students may publish their research results.

Back to Index

Project Title: OpenCAV

Mentor: Venkat Krovi, Michelin Chair Professor

Department: Automotive Engineering

Project Description:

"The Automation Robotics and Mechatronics Lab (https://cecas.clemson.edu/armlab-cuicar/) has pursued a lifecycle treatment approach (design, analysis, refinement, prototyping and validation) for the next generation of multi-scale connected and autonomous cyber-physical vehicles systems. To this end, the research mentor pursued a programmatic approach to characterize variability in distributed multi-scale cyber-physical systems (from components, sub-systems to systems) and use these insights to synergistically engineer and validate system-level performance (reliability, robustness, interactivity, self-awareness and self-optimization).

Deployments in logistics-automation, on-road autonomous-mobility and the newly emerging off-road deployment have helped focus the lab's efforts."

Student Involvement:

The research interns will support the graduate students in their research pertaining to computer-aided design, analysis, refinement, prototyping and validation - furthering both simulation-based design refinement as well as hardware-in-the-loop testing methodology.

Required Skills / Prerequisites:

Prior exposure to CAE tools (SolidWorks, Multibody dynamic simulations); programming languages (MATLAB, R, Python); microcontrollers (Raspberry Pi/Arduino etc.) are desired but not necessary

Expected Outcomes:

Past participants were invited to join the lab's publication - based on the level of participation and engagement of the intern.

Future Opportunities:

Connected Autonomy systems have immense opportunity to provide mobility to bring the right person/part to the right place at the right time for a host of personal mobility, precision agriculture, manufacturing logistics applications.

Back to Index

Project Title: Drug-induced Cardiovascular Toxicity and Mitochondrial Dysfunction
Mentor: Qing Liu, Assistant Professor
Department: Biological Sciences

Project Description:

The team is using human stem cells to make 2D and 3D cardiac models, and is using this models to understand cardiovascular diseases and toxicology. Mitochondria is the powerhouse for energy production (ATP) of the heart. One major project is to understand the mechanism of mitochondrial dysfunction in cardiovascular diseases. The team will apply interdisciplinary and cutting-edge technologies to investigate this scientific question, to promote human health.

Student Involvement:

The students will be mentored by both Dr. Liu and graduate students in the lab. They will attend routine monthly lab meetings and meet in-person with Dr. Liu (every two weeks). The students will read scientific papers, learn stem cell culturing, 2D and 3D cardiac differentiation, and molecular biology techniques. The students will also present their work in the lab meeting and in the public seminar (if possible).

Required Skills / Prerequisites:

Basic laboratory techniques such as pipetting, lab maintenance, reading, and basic biology knowledge are required.

Expected Outcomes:

Students will conduct presentations in the lab meeting and have the potential for authorship in the publications.

Future Opportunities:

Dr. Liu will provide a reference letter and support for students' future fellowships or other applications (graduate or medical schools in future). Students can also continue working in the lab for research credits or CI program.

Back to Index

Project Title: Bio-inspired Drilling into Lunar Regolith
Mentor: Qiushi Chen, Associate Professor
Department: Civil Engineering

Project Description:

NASA's Artemis program aims to land the first woman and first person of color on the Moon and establish the first long-term presence on the Moon, using innovative technologies to explore more of the lunar surface than ever before. Recently, plants and animals and their burrowing mechanisms have become a source of inspiration for novel terrestrial subterranean robots. While still in its infancy, bio-inspired solutions have great potential for NASA's space exploration applications. In this EUREKA! project, students will develop an initial understanding of icy lunar regolith, investigate various bio-inspired drilling and burrowing technologies, and explore their potential as an innovative, energy-efficient solution for in situ characterization and drilling into lunar regolith.

Student Involvement:

The research interns will work within a team of graduate and undergraduate students and faculty mentor. In this research, students will aim to answer the following key research questions:
(1) what are nature's (i.e., plants and animals) solutions to drilling and burrowing into earthen regolith?
(2) what bio-inspired drilling and burrowing technologies have been developed, their hypothesis, and limitations (in particular, limitations with respect to potential lunar applications)?
(3) what are the fundamental material properties of icy lunar regolith and the technical challenges when drilling icy lunar regolith?
Revolving around these research questions, the following activities are planned for the interns:
(1) Survey and understand different types and mechanisms of drilling and burrowing in nature.
(2) Conduct a state-of-the-art review of bio-inspired drilling and burrowing technologies, develop an understanding of bio-inspired design and engineering, and identify 1-2 candidate technologies for lunar drilling applications.
(3) Compile a knowledge base of icy lunar regolith and assist graduate students with ongoing research efforts to experimentally characterize lunar regolith.
(4) Assist graduate students with the modeling of the drilling into lunar regolith, help process research data
(5) Complete the required final report.

Required Skills / Prerequisites:

Students should have strong motivation and interest in NASA research. They should also be able to critically analyze and process technical information from a variety of resources (technical papers, reports, websites, databases, etc.). Students need to be familiar with Microsoft Office and willing to learn new experimental methods and new computer software.

Expected Outcomes:

The interns can present their research outcomes at Clemson's Annual Summer Undergraduate Research Poster Symposium.

Future Opportunities:

"After the interns complete their research experience, there are multiple opportunities to continue getting involved:
(1) Creative Inquiry: students may choose to join Dr. Chen's Creative Inquiry project (#1016 Martian and Lunar Soil Simulants – Characterizations and Feasibility as Building Materials; course number: CE1990/2990/3990-123) in Fall, Spring or Summer semesters.
(2) NASA SC Space Grant Consortium (SCSGC) projects: Dr. Chen has multiple ongoing SCSGC projects that hire and support undergraduate students to conduct NASA-related research."

Back to Index

Project Title: How to Build a Large Language Model (From Scratch)
Mentor: Kai Liu, Assistant Professor
Department: Computing

Project Description:

Large Language Model (LLM), a language model notable for its ability to achieve general-purpose language generation and understanding, has been extremely successful and widely used in many domains. The team will discover how LLMs work from the inside out and build their own small-but-functional model for educational purposes mirrors the approach used in creating large-scale foundational models such as those behind ChatGPT.

Student Involvement:

Students will learn how LLM works and the principles before writing the codes and implementing the model step by step as a team under the faculty's guidance.

Required Skills / Prerequisites:

Students should be fluent in Python and Pytorch.

Expected Outcomes:

Students will build and train a LLM for a specific domain (say US. history or mathematics history) which will inspire others for different areas.

Future Opportunities:

If students successfully complete the project, they are expected to submit one paper to a prestigious conference venue and there are numerous industry internship opportunities upon its success.

Back to Index

Project Title: Ensuring Privacy Compliance in Software Development

Mentor: Long Cheng, Assistant Professor

Department: Computing

Project Description:

With the rise of appification, many open platforms across web, IoT, virtual reality, and autonomous vehicles domains allow third-party developers to create and publish applications (apps) on different app stores, such as Chrome plugins store, Amazon Alexa skills store, and Samsung SmartThings apps store. These apps may collect massive personal information from users. Under these circumstances, it is essential to comply with privacy regulations (such as GDPR, HIPPA, and CCPA) and obtain appropriate consent when collecting, processing, and storing personal data through apps. Transparent privacy policies should be provided by third-party developers to inform users about the purposes, scope, and retention of data collected. Privacy non-compliance issues are quite serious and could lead to costly fines. For example, Amazon recently paid a $25M fine for violating children's privacy with Alexa. In this project, students will learn to use existing tools and natural language processing (NLP) technologies to identify privacy non-compliance issues within privacy policy documents on different platforms.

Student Involvement:

In this project, the team will perform data analysis of Privacy Compliance in Emerging Appified Platforms. The team plans to design a set of tools to facilitate third-party developers in creating privacy-compliant apps in different platforms, including 1) Nature Language Processing (NLP)-based data practice analysis of privacy policies, 2) privacy non-compliance detection with static code analysis, 3) privacy non-compliance detection with static analysis, and 4) automatically generating easy-to-digest privacy policy from app code.

Tentative student activities include working on privacy regulations (students will get familiar with Privacy regulations such as GDPR, CalOPPA, and CCPA, and learn what information should be included in a privacy-compliant software application), data collection (students will learn how to gather a privacy policy dataset from app stores) and privacy policy analysis (students will learn how to use Large Language Models (LLMs) such as ChatGPT to automatically analyze privacy policy documents and detect potential privacy non-compliance issues).

Required Skills / Prerequisites:

Students should possess basic programing skills, in particular Python programing language.

Expected Outcomes:

We expect research interns to be involved in a paper publication.

Future Opportunities:

Research interns have opportunities to continue to do undergraduate research after the summer program ends.

Back to Index

Project Title: Machine Learning-based 3D Reconstruction
Mentor: Siyu Huang, Assistant Professor
Department: Computing

Project Description:

The team will take photos of scenes with smart phones, then the goal is to reconstruct a high-quality 3D model of scenes from these photos. The project involves developing new machine learning methods for those challenging novel view synthesis problems.

Student Involvement:

Students will work as a team. Students will first learn the basics of machine learning and computer vision (especially 3D vision). Then, they will be guided to implement and improve existing state-of-the-art novel view synthesis methods.

Required Skills / Prerequisites:

Students should possess basic knowledge in linear algebra and probability as well as coding in Python and Pytorch.

Expected Outcomes:

Novel and promising results will be extended into top-tier conference submissions.

Future Opportunities:

Excellent and motivated students will have the opportunity to work on research projects in the lab in the future.

Back to Index

Project Title: Adaptive Multi-Tiered, Multi-Task Base Station Infrastructure For Communication-Denied Environments

Mentor: Fatemeh Afghah, Associated Professor

Department: Electrical and Computer Engineering

Project Description:

"This project explores ways to improve how cellular networks work, especially during tough times like natural disasters or emergencies. Right now, these networks can sometimes struggle to stay reliable when there's a lot of demand or if something happens to the towers that send out signals.

To tackle this issue, the team is looking into using special flying and driving machines called autonomous unmanned aerial vehicles (UAVs) and autonomous vehicles. These machines can quickly set up temporary cellular networks, providing communication services in places where they're needed most. But they can do more than just that – they can also help with things like making maps of big areas fast, working in dangerous areas, delivering emergency supplies, and finding and rescuing people.

The main goal is to create a smart system called an aerial and vehicular base station (MTBS) that can adapt and do lots of tasks at once. This system will make the cellular network coverage better and make sure the service is top-notch, even in tricky situations.

The research team is also working on some important research parts of the project. First, they are figuring out how to make models and plans for the UAVs and base stations so they can work well in places like disaster zones. Second, the team is designing ways to plan the routes these machines take to make sure they use their time and energy efficiently. And finally, they are testing everything out in special test environments to make sure it all works like it should.

The cool thing is, when they are done, they will have some tools and programs that teachers and professionals can use to learn more about this kind of technology. It's all about making sure the team is ready to help out when things get tough."

Student Involvement:

"The research interns will work with the team on exciting tasks. Interns will either help the team create models and plans for the flying and driving vehicles the team will use in the project, or design trajectories for these vehicles to follow so they can perform their tasks in an optimized way.

Interns will also assist the team in testing how well the system works. The team will use special computer programs and test environments to simulate different situations and see how the technology holds up. Interns will use cool testbeds like POWDER and Colosseum, along with network simulators like ns-3 and Omnet++, to help with these tests."

Required Skills / Prerequisites:

"The interns are expected to have at least one of the following skills:
i) Programming
ii) Strong mathematical background
iii) Hands-on experience for working with basic tools
iv) Machine learning knowledge"

Expected Outcomes:

The interns, based on the tasks that will be assigned to them, will learn how to use the corresponding testbed or simulator. They will learn how to collect data and perform performance evaluations. The work will hopefully lead to publication, so the students will learn how to write and prepare a research paper.

Future Opportunities:

Such a valuable research experience will prepare the students for the next chapter of life whether it will be a graduate program or industrial company. It will strongly enrich their resume and is considered as a showcase for their ability.

Back to Index

Project Title: Exploring Security Threats to the Use of Smartphones
Mentor: Lan Zhang, Assistant Professor
Department: Electrical and Computer Engineering

Project Description:

This project aims to explore security threats to the use of smartphones, arising from recent advances in artificial intelligence technologies as well as new hardware features.

Student Involvement:

There are several internship positions available for working in teams to explore security threats in smartphone use. The mentor will assign tasks based on personal interests and expertise.

Required Skills / Prerequisites:

Interns are expected to be familiar with smartphone platforms, such as Android, and/or have some background in artificial intelligence technology.

Expected Outcomes:

Other outcomes include smartphone related datasets, open-source code, and potential publications.

Future Opportunities:

Students will gain research expertise regarding software and hardware smartphone platforms as well as certain AI expertise.

Back to Index

Project Title: Evaluation of Large Language Models

Mentor: Yongkai Wu, Assistant Professor

Department: Electrical and Computer Engineering

Project Description:

This project aims to develop a comprehensive evaluation platform for assessing the capabilities and performance of large language models (LLMs), such as ChatGPT. In the era of AI and machine learning, LLMs have emerged as powerful tools for processing and generating human-like text, making it crucial to evaluate their abilities accurately. This platform will serve as a critical resource for researchers, developers, and educators to benchmark LLMs across various metrics, including accuracy, fairness, bias, and creativity.

Student Involvement:

Interns will be directly involved in conceptualizing, designing, and developing the evaluation platform. Responsibilities will include literature review, metric design, programming, data analysis, and documentation.

Required Skills / Prerequisites:

Basic Python programming experience is required. Students should also possess the ability to analyze complex data and draw meaningful conclusions. Strong written and verbal communication skills for documentation and presentation purposes is also needed.

Expected Outcomes:

Publication and new software. The results will be wrapped up and published in top AI venues. The evaluation platform will be released as open-source software.

Future Opportunities:

Upon completion of their research experience, students may have opportunities to:
Co-author research papers or publications based on their findings.
Present their work at conferences or seminars.
Collaborate with researchers and professionals in the field of AI and machine learning.
Continue their research in advanced studies or professional projects.

Back to Index

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 challenges do neurodivergent learners face in higher education, and how do they impact their academic performance?
- What strategies do 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?

The project will use a mixed-methods approach, including quantitative and qualitative data. The research methods will include surveys, interviews, and possibly focus groups. The research team will use surveys to collect quantitative and qualitative data on the challenges that neurodivergent learners face and the support they receive. The team will use interviews and possibly focus groups to collect qualitative evidence on the experiences of neurodivergent learners. This research project will provide a valuable opportunity for the student interns to learn research methods and develop data collection, analysis, and presentation skills."

Student Involvement:

"The research interns will play an essential role in the research project and be involved in various stages of the research process. Specifically, their involvement will include the following.

Literature Review: The research interns will work closely with the project supervisor to comprehensively review the literature on neurodivergent learners in higher education. Creating the review will include searching relevant academic databases, reading and summarizing research articles, and identifying research gaps.

Data Collection: The research interns 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 interns will assist in analyzing the quantitative and qualitative data. The analysis will involve organizing and cleaning data, running statistical tests, and exploring the themes and patterns that emerge from the qualitative data.
Poster Presentation: The research interns will work with the project supervisor to develop a poster summarizing the research findings. They will be responsible for designing the poster layout and contributing to developing the content.
The interns will develop research methods, data collection, analysis, and presentation skills. 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 interns will have gained valuable experience conducting research and presenting findings at the poster forum."

Required Skills / Prerequisites:

"While interns don't need previous research experience, they should be interested in research and willing to learn new skills and techniques throughout the project.
To participate in this research project, the interns should have the following skills, experiences, and knowledge:
- Strong communication skills: The interns should have excellent oral and written communication skills to communicate effectively with research participants, supervisors, and team members.
- Attention to detail: The interns should have excellent attention to detail to ensure that data collection is accurate and complete.
- Organizational skills: The interns 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 interns should have an interest in neurodiversity and a desire to learn more about the experiences of neurodivergent learners in higher education."

Expected Outcomes:

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 universities can provide to better meet the needs of neurodivergent learners.
A poster presentation: The research interns will be able to develop skills in presenting research findings by creating a poster that summarizes the project's key findings. They can present the poster at the poster forum, where they can share their work with other researchers and university community members.
Experience in research methods: The research interns 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.
Collaboration skills: The research interns will be able to work collaboratively with their supervisor and other team members, allowing them to develop teamwork and collaboration skills.
Knowledge of neurodiversity: The research interns will gain knowledge and understanding of neurodiversity and the challenges that neurodivergent learners face in higher education. This knowledge will be helpful for anyone who plans to work with neurodivergent individuals in the future, whether in an academic or non-academic setting.
Additionally, the research findings may be published in academic journals, allowing the interns to be recognized as contributors to academic research."

Future Opportunities:

"Completing this research experience can open up several opportunities for students, including:
Continuing this work: Future opportunities for collaboration with Dr. Boyer and fellow student researchers in the ongoing Creative Inquiry project #2293 on this line of research and development.
Enhancing their resume: Participating in a research experience is an impressive addition to any resume, demonstrating the student's dedication to their field and ability to conduct independent research.
Networking: Research experiences allow students to network with other researchers, professors, and professionals. These connections can be valuable for career development and may lead to future research opportunities.
Opportunities for publications and presentations: If the research findings are significant, students may have opportunities to publish their work in academic journals or present at conferences. Publications and presentations can be valuable additions to their resume and help them establish themselves as emerging experts in their field.
Improved critical thinking and problem-solving skills: Research experiences require students to analyze complex data and draw conclusions based on evidence. Research experience can help students develop valuable critical thinking and problem-solving skills in any career path.

Engaging in a research experience can provide students with various opportunities that can be valuable for career development and personal growth. By participating in this research project, students can gain experience in research methods, develop teamwork and collaboration skills, and gain knowledge of neurodiversity, which can open up a range of future opportunities."

Back to Index

Project Title: Understanding of Retort Processing for Food Safety and Shelf Life of Food Products

Mentor: Sneh Bangar, Post-doctoral fellow

Department: Food, Nutrition and Packaging Sciences

Project Description:

Retort (Thermal) processing is a method for preserving food products by subjecting them to heat (240-250°F or 115-121°C) and pressure (around 15-20 psi or 1-1.4 bar), to ensure that the food remains safe while preserving its quality and value. The main purpose of this treatment is to eliminate microorganisms like Clostridium botulinum to achieve a "Commercially sterile" status for the food. With the increasing demand for lasting and high-quality food items, retort processing has gained importance in the food industry. This preservation technique significantly prolongs the shelf life of fresh produce, enabling longer storage periods without refrigeration, which is particularly beneficial for distribution and retail purposes. While retort processing may slightly affect texture, flavor, and color, it generally preserves the nutritional content of the produce, making it a versatile and effective method for ensuring food safety and quality throughout the supply chain.

Student Involvement:

This project specifically concentrates on the retort processing of low-acid foods. For those engaging in the proposed initiative online, a comprehensive series of PowerPoint presentations, literature reviews, and interactive discussions will be orchestrated to impart to students a thorough understanding of food safety principles and the application of retort processing to enhance the shelf life of low acid foods. Those participating in the proposed project in person will work with graduate students to learn and gain hands-on experience in the retort processing of fresh produce, alongside engaging in packaging techniques and conducting shelf life studies.

The students participating in the project online will read and discuss related research papers on different food processing techniques (thermal and non-thermal), retort processing, food microbiology, and food safety. They will participate in all the online presentations and discussions and actively interact with our graduate students to become familiar with the basics of scientific research on food types and their preservation techniques. The students participating in the proposed project in person will work with graduate students to learn and gain hands-on experience

in the retort processing of fresh produce, alongside engaging in packaging techniques and conducting shelf life studies.

Required Skills / Prerequisites:

No specific skills are required for the students to be involved in this project. Knowledge learned from high school sciences courses will be enough to participate in the project.

Expected Outcomes:

The project would allow students to become familiar with the basics of various food processing techniques, retort processing, food microbiology, and food safety through hands-on experiments, the review and discussion of research papers, and participation in presentations and discussions. They will also be trained to read scientific literature as well as to prepare, present, communicate, and discuss scientific data with their peers and the general public.

Future Opportunities:

Following the EUREKA! Internship, the students could continue their research in the lab, gain more hands-on research experience, and have opportunities to present research data in professional meetings and publish their discoveries.

Back to Index

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

Mentor: 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""). The team's 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 / Prerequisites:

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 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.

Back to Index

Project Title: Plant Biotechnology for Enhanced Agricultural 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.

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 Dr. Luo, graduate students and 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 / Prerequisites:

No specific skills are required for the students to be involved in this project. Knowledge learnt from high school biology courses will be good 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, 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.

Back to Index

Project Title: Gene Expression During Cyst Formation in the Human Parasite Entamoeba histolytica

Mentor: Cheryl Ingram-Smith, Associate Professor

Department: Genetics and Biochemistry

Project Description:

Entamoeba histolytica is a human pathogen that causes amoebic dysentery (a very severe, bloody diarrhea that lasts for several weeks) in ~100 million people each year. E. histolytica has two life forms: the growing amoeba (also called a trophozoite) and the dormant cyst. The cyst form has a hard shell made of chitin and proteins and is able to withstand harsh environments. The amoeba form grows and colonizes the large intestine of humans. Dr. Ingram-Smith's lab studies the processes by which E. histolytica converts from the amoeba to the cyst form (encystation) and back again from the cyst to the amoeba form (excystation). The research team will take a bioinformatics approach to examine gene regulation in E. histolytica with a focus on encystation and encystation to discover genes that may play a role in this conversion between the amoeba and the cyst form.

Student Involvement:

The research interns will use AmoebaDB, a bioinformatics resource center supported by the National Institutes of Health to "provide public access to computational platforms and analysis tools enabling collection, management, integration and mining of genomic information and other large-scale datasets relevant to infectious disease pathogens including their interaction with mammalian hosts and invertebrate vectors of disease". The research team will use the bioinformatics tools provided on AmoebaDB to search for genes whose expression changes early in the encystation and excystation process. The team will then explore the potential role of some of these genes through bioinformatics and the scientific literature. Depending on the results, some of the genes identified could serve as targets for further investigation in the lab.

Required Skills / Prerequisites:

No prior experience necessary. General knowledge of biology is helpful.

Expected Outcomes:

Students will gain experience using bioinformatics approaches and in searching the scientific literature to formulate hypotheses.

Future Opportunities:

Students interested in continuing are invited to join Dr. Ingram-Smith's lab for computational or wet-lab research during the academic year as they are ready (this does not have to be immediately starting freshman year - the door is open for later years as well).

Back to Index

Project Title: Thomas Green Clemson in Paris: 1826-1831
Mentor: Eric Touya, Professor
Department: Languages / Interdisciplinary Studies

Project Description:

"In 1826, supported by his father's trust fund, 20-year-old Thomas Green Clemson went on a grand tour of Europe. Clemson spoke French fluently and, while living abroad, studied at the Paris School of the Mines. He attended lectures of noted chemists Louis Jacques Thenard, Joseph-Louis Gay-Lussac and Pierre-Louis Dulong at the Sorbonne Royal College of France in Paris, one of the oldest institutions of higher education. He later studied at the chemical laboratory at Robiquet, completing his studies at the Royal School of Mines in Paris.

In June 1831, Clemson received his formal diploma as an assayer of mines from the French Royal Mint in Paris. With this degree in hand, he was internationally certified as a mining engineer. In addition to his studies, Clemson became interested in politics. As a student in Paris, he took part in the Revolution of 1830, which replaced Charles X with Louis-Philippe as king."

Student Involvement:

The student will do research on how Thomas Green Clemson's studies in Paris from 1826-1831 impacted his life and thinking. What did he study? Where? How did his studies impact his knowledge and research? How did living abroad and experiencing a different culture for five years shaped his academic, cultural and political thought? How did it shape his thinking on education? How did it possibly impact his future life as founder of Clemson University. The student will work with Dr. Touya exploring these questions and seeking answers in Paris via phone and email and at the Strom Thurmond Institute.

Required Skills / Prerequisites:

No specific skills are required to participate in this project.

Expected Outcomes:

In addition to the poster presentation, the student may continue to work on this research project beyond the summer.

Future Opportunities:

The student will work with Dr. Touya exploring the topic and seeking answers in Paris via phone, email and at the Strom Thurmond Institute.

Back to Index

Project Title: Using Machine Learning to Automate the Assessment of Creative and Entrepreneurial Personality

Mentor: Andrew Wang, Senior Lecturer

Department: Marketing

Project Description:

This study attempts to develop a machine learning model to automatically assess people's creative and entrepreneurial personalities (e.g., innovativeness, risk-taking propensity) by analyzing digital trace data. Students will assist the instructor in collecting, cleaning, and analyzing the data (e.g., social media posts, interviews, and startup pitch videos).

Student Involvement:

Students will be assigned different tasks based on their skills and academic background. In the first step, the instructor and students will work on data collection and cleaning. In the next stage, the instructor will split students into two teams. For students with computer programming and analytics skills, they will help the instructor develop machine-learning models and analyze the data. For students without computer programming skills, they will work with the instructor to conduct qualitative analysis and help draft an academic paper.

Required Skills / Prerequisites:

All students are welcome. A basic RStudio or Python skill is preferable, but it is not required. Students should be hard-working and strong motivation in research.

Expected Outcomes:

The research team plans to present the result at a marketing or management conference and publish our findings in an academic journal.

Future Opportunities:

Students would be welcome to continue participating in this research after EUREKA!

Back to Index

Project Title: Train Neural Networks to Emulate Waves

Mentor: Qingshan Chen, Associate Professor

Department: Mathematical and Statistical Sciences

Project Description:

This project seeks novel ways to train neural networks so that they can accurately and reliably simulate physical phenomena such as wave propagations in a variety of media. The world has recently been mesmerized by the capabilities of neural networks to process and generate images, texts (e.g. chatGPT), and even video clips. But can neural networks be used to solve some of the most challenging problems in science and in our society? Can a neural network be trained as a model that can predict complex phenomena into the future, not just phenomena that it has been fed before? This project explores these important questions, and it seeks and experiments with novel training methods that may lead to models with predictive capabilities.

Student Involvement:

This project will involve 1-2 interns. Under the guidance and help of the faculty member, the intern(s) will (1) study the basics of neural networks; (2) gain a basic understanding of how neural networks are trained; (3) learn how neural networks are constructed, trained, tested, and validated at the code/program level; (4) explore and experiment with various training methods and principles; (5) write up the findings and conclusions in a presentable format.

Required Skills / Prerequisites:

Required skills: some familiarity with a high-level scripting language, such as Python or Matlab, and a willingness to learn, to play, and to mess around.

Desirable skills: knowledge of calculus, pre-calculus, linear algebra, matrix, vector, and basic algebraic operations involving matrices and vectors.

Expected Outcomes:

Expected outcomes: deeper knowledge of neural network, deep learning, and artificial intelligence; improved coding skills, and diminished fear of coding; knowledge of training methods and principles for neural networks.

This project is mainly exploratory. However, it is possible that findings from this project may be suitable for scientific journals that focus on undergraduate research.

Future Opportunities:

More importantly, experience and knowledge interns gain from this summer project will allow them to go further in this fascinating area of machine learning and AI, and make them perfect candidates for many of the related projects on campus, such as robotics, fluid dynamics, etc.

Back to Index

Project Title: Bioinspired Structural Materials by Design

Mentor: Zhaoxu Meng, Assistant Professor
Department: Mechanical Engineering

Project Description:

Nature contains an arsenal of materials with excellent properties. These emergent superior properties are encoded in the intricate and sophisticated hierarchical structures, which offer unparalleled solutions for high-performance structural material designs.

The research project aims to develop and design advanced structural materials by drawing inspiration from various biological materials. EUREKA! research interns will participate in the group's research project of establishing computational models of materials systems (nanocomposites, nanofibrillar films, etc.) with bioinspired structures and understanding their mechanical properties through computational simulations. The research activities include reading scientific journal papers, learning essential skills to develop computational models for bioinspired material systems, conducting computational simulations on Clemson's high-performance computing cluster to study the mechanical properties of the material systems, and summarizing results.

Student Involvement:

The research interns can form a team and participate in the team's ongoing research projects. They will also learn how to construct computational models, conduct simulations, and analyze results from Dr. Meng and graduate student mentors. The research interns will have weekly meetings with Dr. Meng and more frequent communications with graduate students to discuss their questions and update results. They are also welcome to join biweekly group meetings to learn about research projects conducted by the graduate students.

Required Skills / Prerequisites:

Prior MATLAB or Python experience is preferred but not required. Students will also need to setup their Clemson VPN.

Expected Outcomes:

The research interns will learn critical skills for conducting computational materials science, which has a strong potential for revolutionizing materials design and development. They will also learn about research frontiers and develop a broader knowledge base and scientific perspectives. They can also publish journal articles as co-authors

with our group in reputable journals, which may give them the unique advantage for Fellowship or graduate school applications. Dr. Meng's prior undergraduate mentees are currently enrolling in graduate schools at Stanford, Northwestern University, UT Austin, etc.

Future Opportunities:

The research interns will have the opportunity to continue doing research with Dr. Meng's group and work on their Honors research thesis. With potential significant contributions to research projects, they will be included as co-authors for journal publications.

Back to Index

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 the research interns will be first assessing these to compare them later. To this end, the research interns 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 the team will start testing. In collaboration, the team 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. Are you ready?

Student Involvement:

The research interns will be working in a team-oriented lab environment that includes both undergraduate and graduate researchers. The lab is goal oriented and as such interns will be given a goal to accomplish by the end of their tenure (comparing the life cycle analysis of both types of cellulose). In collaboration with the PI, interns 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 / Prerequisites:

Research interns must be curious, comfortable with ill-defined problems, and strongly willing to pull threads in multiple areas. Above all, interns must be excited to come to work and craving to engage with the team. Experience analyzing scientific literature is desired but not required. Research interns must also install Clemson VPN.

Expected Outcomes:

Interns will learn how to do a life cycle analysis of a product and its process. They 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.

Back to Index

Project Title: Experimental and Computational Cardiovascular Research

Mentor: Ethan Kung, Associate Professor

Department: Mechanical Engineering / Bioengineering

Project Description:

In this project students will calibrate, prototype, and test devices that can improve the capabilities of a benchtop experiment which generates realistic pressure and flow waveforms mimicking human cardiovascular system. The ultimate purpose of such experiments is to provide a realistic benchtop environment that can be used to test cardiovascular medical devices and surgeries. The project may extend to computational modeling of the cardiovascular system and related medical devices.

Student Involvement:

In-person students will learn about how to conduct benchtop flow experiments and carry out technical work relating to obtaining accurate flow and pressure measurements, and prototyping solutions for how to generate proper pressure and flow in experiments. They will implement a combination of actuators and sensors to realize the design solution in a physical construction of the device prototype. Remote participants may perform computational modeling, simulations, and data analyses to answer scientific or clinical questions. The computational models that the research group employs include low-order circuits models and high-order 3D finite element models.

Required Skills / Prerequisites:

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

Expected Outcomes:

The program should result in the participants gaining the knowledge for how to conduct a cardiovascular related flow experiment or computational modeling. Products may include completed device calibration, advancements in device prototype development, new scientific findings, or computer simulation results that can aid clinical understanding of cardiovascular diseases.

Future Opportunities:

After EUREKA!, students may continue related research in Creative Inquiry or summer research.

Back to Index

Project Title: A Pilot Study of Undergraduate Students Major Change Behaviors

Mentor: Miao Li, Assistant Professor

Department: Sociology, Anthropology and Criminal Justice

Project Description:

Based on the restrictive data from the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD), the project aims to create a ready-to-use integrated data set and generate preliminary findings on undergraduate major change and retention in American Public Universities. Data products and pilot findings from this project will be used to support the NSF grant proposal development.

The MIDFIELD data included anonymized student-level records (including zip code) for over 1 million undergraduates enrolled in 19 public universities from 1987 to 2017. The data also have over 8 million term-level records and 51 million course-level records. Interns will be tasked to 1) link these databases based on unique student identifier, 2) construct time-varying variables on student major switching behaviors and academic performance, and 3) identify individual-level and neighborhood-level predictors for successful major switching behaviors (defined as timely graduate with a GPA>=3.0).

Interns will gain hands-on experiences in managing large-scale data, creative visualization, and exploratory data analysis. They will also gain a deeper understanding of the higher education landscape by examining their peers' academic experiences.

Student Involvement:

Each intern will be assigned with data from ONE institution (e.g., Clemson University, Purdue University, etc) and complete the following tasks:

1. Data cleaning, linkage, and visualization
2. Preliminary data analysis using cross-tabulation, t-test, chi-square test, and/or regression models

Required Skills / Prerequisites:

Students should have basic to intermediate training in using R (e.g., understanding the basic gramma of the R language, know how to install and use packages, preferably with some experiences with the tidyverse package for data processing and the ggplot2 package for graphing). They should also have entry level understanding of Strata, a very user-friendly software.

Expected Outcomes:

The interns will help construct a Github website for data visualization.
Interns will also have opportunity to coauthor on peer-reviewed publications.

Future Opportunities:

The interns with outstanding performance will have the opportunity to continually participate in future NSF funded project developed based on this preliminary research project.

Back to Index

Project Title: Seeing the Bigger Picture: Analyzing Body Size Representation in Picturebooks
Mentor: Koti Hubbard, Lecturer of Early Childhood Education
Department: Teaching and Learning

Project Description:

Children as young as three years old demonstrate a propensity for evaluating their own and their peers' bodies, with some displaying an inclination toward the "thin ideal." Given the influential role of media, particularly children's literature, in shaping perceptions of self and others, Dr. Hubbard's research project aims to build upon existing studies by investigating the representation of fatness in recently-published children's picturebooks. Through a content analysis of the words, illustrations, and other design elements (e.g., front and back cover), the research group seeks to identify recurring patterns in the portrayal of fatness and the messages conveyed about body size and diversity.

Student Involvement:

Research interns will receive 10-15 picturebooks featuring fat characters. Each week, interns will read a selection of these picturebooks. With guidance and support, interns will take notes to identify recurring patterns or themes related to messages about fatness in the books. The reserach group will discuss these patterns and collaboratively develop a system for coding the messages we observe. Subsequently, interns will revisit the picturebooks, applying the coding system to identify and categorize themes related to fatness and body size representation. The research group will meet and work as a team throughout this process.

Required Skills / Prerequisites:

Interns should be interested in children’s literature and curious to explore their own biases concerning body size, as these biases could impact their analysis of the picturebooks.

Expected Outcomes:

The project outcomes include a understanding of picturebook design, developing proficiency in analyzing picturebooks and ways they convey messages to young readers, heightened awareness of body size representation in children’s media, and acknowledgment as an author or presenter in any publications or presentations that might result from this research endeavor.

Future Opportunities:

Interns can enroll in Dr. Hubbard's Creative Inquiry course, which centers on evaluating picturebooks and crafting a book review column for early childhood and elementary educators in South Carolina.

Back to Index