List of CSI CRSP students and their abstracts presented at the 2026 CRSP Symposium

Hyperphosphorylated Tau Promotes Neurodegeneration Through Oxidative Stress Mechanisms

Celine Abbas
Mentors: Dr. Alejandra Alonso, Richard Candia

Oral Presentation Award Winner

Alzheimer's disease (AD) is a progressive neurodegenerative disorder and the leading cause of dementia worldwide. While amyloid plaques and tau tangles are well-established hallmarks of AD, treatments targeting amyloid pathology have shown limited clinical success, highlighting the need to investigate alternative mechanisms of disease progression. The purpose of this study was to examine the role of hyperphosphorylated tau (PH-tau) in neurodegeneration, with a focus on its response to oxidative stress. To carry out this study, western blotting and flow cytometry experiments were used to evaluate tau aggregation and cellular toxicity under various conditions. The results showed that acute oxidative stress altered tau behavior, while chronic oxidative stress promoted increased tau aggregation and toxicity. PH-tau exhibited greater toxicity than wild-type tau under both acute and chronic stress conditions. These findings suggest that oxidative stress exacerbates tau-mediated neurodegeneration and may contribute to disease progression through mechanisms beyond tau's traditional role in microtubule stability. This study provides further insight into the relationship between oxidative stress and tau pathology and highlights potential therapeutic targets for Alzheimer's disease and related tauopathies.

Filled Pauses in Spontaneous Speech

Ashley Wallace
Mentor: Dr. Jason Bishop

Filled pauses such as "uh" and "um" are often viewed as signs of hesitation or disfluency in speech. However, rather than error or processing difficulty, it is also possible that these vocalizations serve a communicative purpose, such as letting the listener know that a silent pause or other disruption may be about to occur. The present study is part of a larger investigation, still in progress, that aims to identify individual variation/individual differences in how people use filled pauses. In this preliminary analysis, we explore how filler words like "uh" and "um" might function differently in spontaneous speech collected in the CSI Speech Laboratory.

Altered Pre-Pulse Inhibition and Acoustic Startle Reflex as Potential Early Biomarkers for Autism Spectrum Disorder

Adam Adler
Mentor: Dr. Abdeslem El Idrissi

Autism spectrum disorder (ASD) is a neurodevelopmental condition that affects millions of individuals worldwide. Children diagnosed with ASD often require substantial support, and early intervention is widely recognized as a critical factor in improving developmental outcomes. Despite this, current screening methods present significant challenges. Although early behavioral signs may emerge as early as two years of age, many children are not formally diagnosed until much later, delaying access to essential services. Emerging research suggests that alterations in the acoustic startle reflex may serve as a potential early biomarker for autism. Specifically, abnormalities in pre-pulse inhibition, a neurological process that reflects the central nervous system's ability to modulate sensory input, have been observed in individuals with ASD. These findings show that mice with fragile x syndrome have almost no inhibitory response to a pre pulse startle when compared to a control group of non-fragile x mice. This study investigates the effects of pre-pulse inhibition in fragile x mice using a startle response chamber to better understand how the central nervous system processes sensory stimuli. Electrophysiological techniques are employed to measure neural activity associated with neuronal excitability. By examining these responses, the research aims to clarify how alterations in pre-pulse inhibition impact central nervous system function and to further elucidate its relationship to autism. This research shows that mice with the fragile x gene have almost no inhibitory response to the pre pulse startle, meaning that it could serve as a potentially early biomarker for autism spectrum disorder.

Human vs Machine Text Classification: An Inquiry into Methods of AI-Generated Text Detection

Malaak Ghanem
Mentor: Dr. Sarah Zelikovitz

One problem that Artificial Intelligence classification systems have trouble with is distinguishing between human-written and AI generated text. In academia particularly, there is a growing problem of students using generative AI to write their work for them, which is a threat to academic integrity. For this project, a machine learning model is trained to classify text as either AI-written or human-written. The project also includes an exploration of how accuracy increases based on the amount of data used in training and based on the number of epochs, that is, the number of times that the model goes over the same data that are used in training. A review is done on current scientific papers to compare how machines and humans distinguish between human-written and AI-generated text. The literature shows that humans, including experts in linguistics, generally fare worse than classifier models. In this project, a model is trained on equal-sized sets of short human-written and AIgenerated text from a large public dataset to predict any given text snippet as belonging to either category. A small dataset was then curated using a Large Language Model (LLM) to generate the sample AI text and the sample human text was taken from various sources. The model is tested on this new dataset to determine how well it performs on unfamiliar data. Later, we took a portion of the human data and prompted generative models to fix errors that could bias the classifier. The classifier still performs well on the test samples with many of the errors removed. Then the model was tested again on the custom samples. We found that the accuracy score was no higher than chance for both the edited and unedited versions of the dataset.

The Effects of Chronic Social Isolation During Adolescence on Dopamine Axonal Varicosities in the Corpus Callosum

Gianna Albano
Mentor: Dr. Leora Yetnikoff

Prolonged social isolation alters stress and motivation, making it a valuable model for understanding how environmental factors can shape behavior and neural plasticity. Previous work from our lab and others have shown that socially isolated mice exhibit altered density of oligodendrocyte precursor cells (OPCs), and disrupted paranode and nodal organization within the corpus callosum, compared to group-housed mice. OPCs are self-renewing cells that, upon differentiation, give rise to myelin-producing oligodendrocytes, suggesting that social isolation remodels myelination within the corpus callosum. However, the neurochemical mechanisms by which this occur is not known. We recently demonstrated that axons arising from midbrain dopamine neurons innervate the corpus callosum and that they are malleable. Specifically, chronic social isolation - either during adulthood or throughout development - increases the density of corpus callosal dopamine terminals. Here, we asked whether the increase in dopamine terminal density is accompanied by changes in dopamine axon varicosities, small presynaptic swellings where neurotransmitter vesicles are located. Because the organization of varicosities contributes to release probability and synaptic efficiency, structural remodeling of these sites could provide insight into the mechanisms through which social isolation reshapes circuitlevel communication. To investigate this question, male and female mice were reared under conditions of group-housing or social isolation (P21 - P56). Brains were then obtained and dopamine axon varicosities in the corpus callosum were identified by tyrosine hydroxylase immunofluorescence and measured using IMARIS software. Analyses indicate that chronic social isolation throughout adolescence causes an increase in the size and density of corpus callosal dopamine axon varicosities, suggesting that social isolation has an enduring effect on the organization and function of dopamine release within the corpus callosum. In examining how social isolation affects presynaptic structure of dopamine axons within the corpus callosum, alongside previously observed changes in myelination, these findings contribute to a broader understanding of how social environments shape neural plasticity and behavior.

Design and Analysis of Vertical Axis In-pipe Hydro Turbine

Angelo Perera
Mentor: Dr. Zeda Yin

The United States continues to consume substantial quantities of non-renewable energy resources each year, resulting in significant environmental pollution and long-term ecological consequences. Continued reliance on fossil fuels not only accelerates greenhouse gas emissions but also intensifies air quality degradation and resource depletion. These challenges underscore the urgent need to transition toward smarter, more efficient, and sustainable energy generation systems. With the growing global demand for renewable energy, innovative and decentralized generation technologies are increasingly essential. An in-pipe hydro turbine system presents a compact and efficient solution for electricity generation by harnessing the kinetic energy of fluid flow within existing pipeline networks. This approach enables energy recovery without the need for large-scale infrastructure development. The purpose of this research was to design a vertical axis in-pipe turbine blade to maximize efficiency and find the optimal operating tip speed ratio. A three-dimensional turbine blade was designed using FreeCAD under the guidance of my mentor. The aerodynamic performance of the blade was evaluated using Computational Fluid Dynamics (CFD) analysis conducted in OpenFOAM. The resulting performance data were analyzed and compared to determine the more efficient design based on key parameters such as pressure distribution, velocity profiles, and overall efficiency. This turbine design can be implemented into systems like stormwater, sewer, combined water systems.

Contribution of a Singlet Oxygen-Derived Secondary Products to Prolonged Antibacterial Effects Following Antimicrobial Photodynamic Therapy (aPDT)

Patrick Gerges
Mentor: Dr. Alan Lyons

Antimicrobial Photodynamic therapy (aPDT) uses light and a photosensitizer to kill bacteria through the production of singlet oxygen, a highly reactive species with a short lifetime (< 4 microseconds) and limited travel distance (<200 nm) through a bacterial biofilm. However, bacterial killing is observed long after the photogenerated singlet oxygen decays back to breathable oxygen. This suggests singlet oxygen reacts with biomolecules to form longer-lasting oxidized products that continue bacterial killing. This study seeks to demonstrate that reactions of singlet oxygen with biomolecules such as amino acids and proteins form peroxides that continue killing bacteria in the dark after photodynamic therapy. Acrylic lightguides coated with a photosensitizer were used to generate singlet oxygen when illuminated with a red LED. Solutions of different amino acids were treated with aPDT and added to planktonic bacterial suspensions. Histidine and tryptophan were tested because they are common residues in proteins and are known to react to form peroxides with singlet oxygen. The effects of amino acid type, irradiation time, incubation time, and temperature were compared by plating E. coli and measuring CFU levels. Concentrations of histidine-generated peroxides increased with longer light exposure times, which led to greater killing of E. coli, especially at 37°C. Hydrogen peroxide controls showed similar concentration-dependent killing. Light-irradiated tryptophan also reduced E. coli survival, and longer incubation times generally increased bacterial killing. Radical scavengers and singlet oxygen quenchers were used to help identify the reactive species responsible for bacterial killing. Results suggest that peroxides formed during singlet oxygen reactions with biomolecules decompose to form radicals that contribute to continued bacterial killing after light exposure. These findings improve our understanding of how antimicrobial photodynamic therapy works and may lead to safer, more effective light-based treatments in healthcare.

ProvenanceGate: Provenance Aware Delegation for Secure Multi Agent AI Workflows

Xia Jie Ou and Daniel Voyevoda
Mentor: Dr. Sos Agaian

Organizations rapidly adopt AI agents that analyze untrusted content and execute actions with various tools and helper agents. This introduces new security challenges, particularly in multi-agent systems. These workflows are susceptible to indirect prompt-injection attacks and deputy problems, in which an attacker embeds malicious instructions within seemingly harmless content, such as emails, tickets, or documents. A significant issue is second-order prompt injection, which happens when malicious text is stored in trusted data, such as database entries or support tickets, and is later executed by AI agents. Unlike first-order attacks, the harmful input isn’t directly from the user, making detection and tracing more difficult. We introduce ProvenanceGate, a lightweight system that adds provenance tracking to multi-agent AI workflows. ProvenanceGate attaches a small “influence summary” to every tool call and every agent-to-agent request. These summaries track where information came from, how trustworthy it is, and whether it may contain untrusted or risky content. The system builds a detailed source-to-action graph that shows the full chain of influence behind any decision an agent makes. Using this graph, ProvenanceGate can enforce rules as soon as an action is taken, such as blocking irreversible or sensitive operations unless the entire provenance chain is clean or explicitly approved by a human. This approach provides full end-to-end traceability, faster root-cause investigation, and strong protection against attack.

Identifying Plastics and Producing a Specialized Spectral Library Using FTIR Spectroscopy

Jalil Otajonov
Mentor: Dr. Jane Alexander

The extraction of fossil fuels has driven the production of cheap plastics, cementing our reliance on single-use items, and resulting in the ubiquity of plastic debris and microplastics in the environment. While projects by CSI's graduate students have enabled monitoring through sampling of Staten Island's seawater and beach sand, with expansions to wetland coring, a method of identification and indexing was needed to properly distinguish true plastics from lookalikes, such as natural fibers. This study evaluated the efficacy of FTIR spectroscopy as our identification technique and included collecting spectra for a range of everyday materials to build a specialized spectral library. Efficacy was demonstrated by analyzing the precision of the Nicolet Summit X Spectrometer using different numbers of scans and on different days to examine the variability in the spectrum of each sample. Multiple colors of fleece fabric were also used to test the effect of dyes by comparing the produced spectra, along with analyzing single-use items with a complex composition that included plastic, such as tea bags. The accuracy of our technique was evaluated by comparing spectral peak locations in the measured spectra to the best matches from the FLOPP database. Best matches were found using correlation to identify the closest match to our produced spectra. Preliminary analysis showed no changes to the best match or spectral peak locations when testing for accuracy. No spectral variation was observed for the dyed fleece samples or between different days. Furthermore, 16 scan runs were found to be sufficient compared to 32. With the accuracy of FTIR spectroscopy and precision of our spectrometer confirmed, the current sample data will be used to create a spectral library for students working with microplastics, complementing the existing FLOPP library by adding a greater range of samples.

Identification of Major and Trace Elements Using X-ray Fluorescence and ICP Analysis After Acid Digestion and Lithium Metaborate Fusion

Finley Pan
Mentor: Dr. Jane Alexander

Many geological processes can be interpreted based on the chemical analysis of rocks. However, finding an accurate measurement of elemental concentrations can be difficult, with different analytical techniques offering varying levels of reliability. This study aims to investigate the applicability of portable X-Ray Fluorescence (pXRF) in identifying major and trace elements, evaluating its accuracy compared with external laboratory methods using Inductively Coupled Plasma (ICP analysis) after both acid digestion and lithium metaborate fusion. Six different sedimentary rock powders, including a NIST standard, were prepared and analyzed by pXRF and also sent for laboratory testing. The pXRF results are compared with ICP analysis laboratory data, evaluating the elements present in both the ICP analysis and the pXRF analysis. The data collected allowed the XRF to be calibrated using the equation of the best-fit line on plots of results from pXRF against lab analysis. This calibration was then tested by running a different set of 20 samples on the calibrated pXRF and comparing these results with previous lab analysis. The ICP analysis revealed a significant discrepancy in several elements including Zirconium (Zr), due to the mineral Zircon ($ZrSiO4$) being resistant to acid digestion, resulting in it being under-reported using this method compared to the lithium metaborate fusion method. Additionally, statistical analyses will be conducted to determine if there are significant differences in accuracy or yield across varying XRF beam times. By finding the accuracy of the pXRF by calibration and understanding the gaps in accuracy between pXRF, acid digestion, and lithium metaborate fusion methods, researchers in the future can more accurately find the best method for the rocks being analyzed and the elements of interest.

Multi Light Band Analysis of Concentration, Asymmetry, and Smoothness (CAS) of E+A Galaxies with Data From the Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST)

Isabella Troy Brazoban, Lorik Fazliu, and Ali Phillip
Mentor: Dr. Charles Liu
Poster Presentation Award Winner

The study of galaxy morphology has historically been constrained by observational limits. The Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST), generating approximately 20 terabytes of raw astronomical data per night, presents an unprecedented opportunity to resolve this data bottleneck. This ongoing preliminary research develops an automated morphological classification pipeline within the Rubin Science Platform to efficiently identify post-starburst (E+A) merger remnants. Utilizing Jupyter notebooks, we processed photometric data across six optical and near-infrared light bands (u, g, r, i, z, y). To manage this massive data volume, the methodology prioritizes scalable software architecture. SQL queries isolated the target galaxies to a localized database, enabling time-efficient, iterative querying without requiring repeated raw data pulls. The initial query included 100,000 objects which were filtered using specific magnitudes. Filters included the u-band (u) where ($15.0 \leq u \leq 21.0$), the differences of the u and g-band (g) where ($1.0 \leq u - g \leq 1.8$), and the g and r-band (r) where ($0.3 \leq g - r \leq 0.85$). The isolation of this transition zone (known as the "Green Valley") yielded a refined sample of 103 target galaxies (out of 100,000). While the Conselice (2003) Concentration, Asymmetry, and Smoothness (CAS) framework is well-established, applying it at the LSST scale requires novel computational infrastructure. To automate the Conselice framework, the CAS parameters were manually engineered using composite model fluxes and second-order shape moments. Concentration was derived from flux-weighted radii, asymmetry was computed through 180-degree flux array mirroring, and smoothness applied a scipy uniform filter, dynamically scaled to 0.3 of the approximated Petrosian radius to isolate structural clumps while preventing null processing errors. The establishment of this automated foundation is a step toward conducting large-scale analyses of cosmic merger rates and understanding how mass, age, and underlying structure dictate galactic evolution.