2025 STAR SCHOLARS SUMMER SHOWCASE

DREXEL UNIVERSITY
Undergraduate Research & Enrichment Programs
Pennoni Honors College

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The STAR Scholars Program is administered by
Undergraduate Research & Enrichment Programs,
a unit of the Pennoni Honors College.

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A MESSAGE FROM THE DEAN

As I complete my first year as Dean of the Pennoni Honors College, I am thrilled to celebrate the work of our STAR Scholars. The STAR Scholars Program embodies the transformative power of undergraduate research at Drexel. As the University's flagship initiative for early engagement in research, it offers rising second-year students the rare opportunity to immerse themselves in faculty-mentored projects in research, scholarship, and creative work that shape their academic paths and expand their ambitions.

This year's STAR Scholars Showcase is the culmination of months of inquiry and innovation. Our STAR Scholars, representing a diverse array of majors and disciplines across the University, have worked side by side with dedicated faculty mentors whose guidance and expertise have been instrumental to their success.

Undergraduate research is a cornerstone of experiential learning at the Pennoni Honors College. We are committed to supporting all students who wish to explore how research, scholarship, and creative work can enhance their Drexel experience.

As we celebrate the remarkable achievements of our STAR Scholars, I extend my deepest gratitude to our faculty mentors, application reviewers, and the Undergraduate Research & Enrichment Programs team at Pennoni, whose dedication makes this program possible. We look forward to supporting our STAR Scholars and all Pennoni Honors College students on their academic, scholarly, and professional journeys.

Dr. Neville Vakharia
Dean, Pennoni Honors College

A MESSAGE FROM THE DIRECTOR

Welcome to the 2025 STAR Scholars Summer Showcase. The STAR Scholars Program, Drexel's flagship early undergraduate research program, engages highly motivated, rising second year students in a full time, faculty mentored research, scholarly, or creative experience during the summer between their first and second years. Students who apply for and are accepted into this program are intellectually curious and deeply motivated to learn, and today's presentations are the culmination of that curiosity and drive to create knowledge in their fields. Our 116 STAR Scholars represent over 45 different majors and were mentored by faculty from 10 of Drexel's colleges and schools, showcasing the breadth of research and scholarly work undertaken this summer. We thank our faculty mentors, graduate students, and all individuals involved in shepherding our STAR Scholars through this summer and to this point.

This year marks the 23rd cohort of the STAR Scholars Program. In that time, we have had over 2,500 Drexel students participate in this transformative, immersive experience, with nearly 2,000 of our STAR Scholars going on to graduate from Drexel. Nearly 70 of those alumni returned to the fold this year by helping us select the 2025 STAR Scholars cohort. We thank those alumni for their contributions as application reviewers in helping us select students for this year's cohort with thoughtfulness and care.

We are so proud of our 2025 STAR Scholars and are thrilled to celebrate their incredible accomplishments. Congratulations to the 2025 STAR Scholars – we can't wait to see what you do next!

Jaya Mohan, MA
Director, Undergraduate Research & Enrichment Programs

OUTSTANDING MENTOR OF THE YEAR

The critical piece of the STAR Scholars Program that makes it such a valuable experience for the students is, without a doubt, their Mentors. The STAR Mentors give much to their students' summer experiences and do so with no compensation.

In Summer 2011, we created a process to recognize the STAR Mentors and to particularly celebrate the Outstanding Mentor(s) of the Year. STAR Scholars are given the opportunity to nominate their faculty mentors for the "Outstanding Mentor of the Year" award, which provides the awardee with a $1,000 award to futher their research with undergraduate students. Since 2011, twenty-two faculty have been named Outstanding Mentor of the Year.

Each nominated mentor receives a letter signed by the Provost that outlines the common characteristics held by all nominated Mentors, and each letter includes excerpts from the students' nomination letters to provide an individualized account of just how these Mentors have contributed to those specific students' experiences.

Based on these nominations, outstanding Mentors:

- Are passionate experts in their field who freely share their expertise with students
- Care deeply about their students and treat them with respect
- Generously foster students' intellectual and professional development
- Actively engage students in learning and celebrate their success
- Go above and beyond in supporting their students

Our Mentors go beyond the call in their work with STAR Scholars, and we are genuinely grateful for the time and effort they commit to furthering the education of undergraduate students.

2024 STAR SCHOLARS PROGRAM: OUTSTANDING MENTORS OF THE YEAR

Jill Moses, MFA

Jill Moses, MFA, is an Associate Teaching Professor in the Department of English and Philosophy and the Assistant Director of the First-Year Writing Program. In addition, she teaches Academic and Career Exploration classes in the First-Year Exploratory Studies Program at Goodwin. Her passion is to encourage and connect with students, especially first-generation college students (since she is first-generation herself). Jill likes to develop curriculum, and to explore poetry, creative writing, and expository writing in innovative ways. Jill is also the faculty advisor to the student-led Women's Empowerment Club.

In Summer 2024, Prof. Moses mentored Khristina Cabrera, an English major whose STAR project focused on Filipina identities.

In her nomination letter, Khristina wrote, ***"As a poet herself, Professor Moses also understood my passion for the intersectionality of research and creativity. Originally, I was under the misconception that because STAR is a research program, I should sacrifice my imagination to only write in academic jargon. She reminded me that creativity is a large part of who I am, and thanks to her encouragement, I have been writing a series of experimental essays that aren't limited by conventional bounds. This has included creative non-fiction about my experience as a Filipina-American and poetry in the voices of Filipina feminist leaders. Professor Moses taught me that research doesn't need to look a certain way, and that hiding away one's inherent creativity does more harm than good. [...] As this program comes to an end, I can confidently say that Professor Moses helped me embrace my identity as a writer."***

2024 STAR SCHOLARS PROGRAM: OUTSTANDING MENTORS OF THE YEAR

Edward Kim, PhD

Edward Kim, PhD, is an Associate Professor in the Department of Computer Science at Drexel University. He graduated from Lehigh University in 2013 with a PhD in computer science. He has a MSE and BSE from the University of Pennsylvania in the areas of computer graphics and game technology and computer science. Dr. Kim performs research in the area of computer vision, sparse coding, neuromorphic computing, medical image processing, computer graphics, artificial intelligence, and game development. Kim was the recipient of the 2019 NSF CAREER Award in Robust Intelligence.

Dr. Kim mentored two STAR Scholars in 2024, Shams Abrar and Bhavika Choudhary, both computer science majors. In their joint nomination letter, Shams wrote, ***"One of the most remarkable aspects of Dr. Kim's mentorship is his ability to guide without micromanaging. He has an exceptional talent for fostering independence, encouraging me to explore and solve problems on my own. Rather than holding my hand throughout the journey, he provided the tools, resources, and confidence needed to tackle the research independently. This approach not only boosted my self-reliance but also allowed me to develop critical thinking skills that will serve me well beyond my time as a STAR Scholar."***

Bhavika shared, ***"Dr. Kim invested in my professional development. He took the time to understand my career aspirations and encouraged me to present at conferences and even consider writing a paper based on my research. His passion for his field was evident not only in the breadth of his knowledge but also in the variety of innovative projects he was involved in. This passion was contagious and further fueled my enthusiasm for the subject. Dr. Kim has had a lasting impact on my academic journey, so much so that I now plan on remaining involved in research throughout my time at Drexel (and beyond). His mentorship was more than just guidance; it was a partnership in learning that equipped me with the skills, confidence, and inspiration to continue pursuing research."***

2024 STAR SCHOLARS PROGRAM: QUICK PITCH COMPETITION

The Quick Pitch Competition gives STAR Scholars the opportunity to distill their STAR projects into a three-minute, one-slide explanation to a general audience.

Up to 10 students participate in each of four preliminary sessions scheduled during the second half of the summer term. A panel of judges comprising of Drexel staff and faculty select two winners from each session to advance to the finals. Eight finalists present their Quick Pitches at the finals, and three winners are selected.

2024 STAR Scholars Quick Pitch Competition winners:

First Place: Riya Dhiman, biomedical engineering '28
"Neuroergonomic Human-Robot Interaction"
Faculty Mentor: Dr. Hasan Ayaz

Second Place: David Chuquillanqui Cuenca, biomedical engineering '28
"Making PLGA Microparticles of Specific Size Ranges for Drug Delivery"
Faculty Mentor: Dr. Kara Spiller

Third Place: Sam Simon, biological sciences '28
"Patterns of multiple paternity in populations of urban and rural Mus musculus"
Faculty Mentor: Dr. Megan Phifer-Rixey

2025 STAR Scholars Abstracts

Build a Better System: Reclaiming Design from Bias

Amir Johnson

Antoinette Westphal College of Media Arts & Design
Game Design & Production

Dr. Ari Gass
Faculty Mentor
Digital Media

Systemic oppression is a deliberate design; Its rules, rewritten in new forms, decide who moves forward and who is held back. Michelle Alexander's *The New Jim Crow* shows how racism exists in our prison system, specifically, who gets policed, arrested, represented, and believed, and whose narratives are preserved or erased. Aaron Trammell's *Repairing Play* reveals how oppression shapes which voices are reshaped to fit dominant norms, whose culture and knowledge are deemed legitimate, and the historical exclusion of certain types of play. Systemic oppression works quietly, through choices designers make that reward conformity and penalize difference. In Game Design, people decide what is considered useful, beautiful, valid, or professional, and build the spaces, products, and platforms that shape daily life. My research informed the creation of a framework for empowering design, which I used alongside an iterative game design process that included brainstorming, playtesting, feedback, and refinement to develop supplemental materials, and *Eyes on the Wire*; A cooperative board game that models how systemic harm spreads, adapts, and can be dismantled through collective action.

Vladislav Smolkov

Antoinette Westphal College of Media Arts & Design
Game Design & Production

Dr. Frank J. Lee
Faculty Mentor
Digital Media

Klara Proffen
Co-Mentor

Visualizing and Popularizing The Large Hadron Collider

In 2008 after 10 years and 10,000 scientists, The Large Hadron Collider was completed, becoming the world's largest particle accelerator and enabling breakthrough research in physics. However it has largely been unrecognized. Unlike astronomers and biologists who can showcase findings using beautiful images made by telescopes and microscopes, physicists face challenges in translating their work for broader audiences.

To solve these challenges we came up with a visualization tool showing how the CMS particle detector works. Using Unreal Engine I created a realistic 3D visual of the detector, allowing people to observe inner functions and particle collisions. Analyzing available documentation, I gathered reference materials both online and from Dr. Lawrence Lee, a Professor of Physics & Astronomy, to be as realistic as possible.

Through this program we can display giant interactable models of the detector with particle simulations in both Augmented & Virtual Reality. Helping us conduct outreach to elementary, middle, and high school students. Demographics that understand complex topics much easier with visual representations. This visualization will allow the Hadron Collider with its complexity to get the recognition it needs.

Reconstructing Charles Willson Peale's Mastodon Excavation and Display Through AI

For this project, I created a short AI-animated video depicting Charles Willson Peale's excavation and display of the mastodon circa 1801. This event introduced the idea of extinction to the American public and played a key role in shaping early American science. Peale, a painter, natural historian, and museum founder, left letters that I used to develop a script visualizing the fossil recovery and display process. I used Google's Gemini AI, a multimodal tool capable of processing text, images, audio, and video, to generate the animation. Additionally, I sculpted a 3D model of the mastodon skeleton based on Peale's notes and historical images, without using AI. My research focused not only on history but also on how to visually represent it in a way that felt accurate and compelling. Working with traditional methods alongside AI gave me greater control over storytelling. A project of this scale would not have been possible for one person to complete in 10 weeks without AI tools. As an animator, the experience demonstrated the strengths and limitations of AI, challenging me to think differently about creativity. It has prepared me to engage more thoughtfully with emerging technologies that continue to shape animation's future.

Aaron W. Mosier

Antoinette Westphal College of Media Arts & Design
Animation & Visual Effects

Dr. Glen Muschio
Faculty Mentor
Digital Media

Hani Pham

Antoinette Westphal College of Media Arts & Design
Animation & Visual Effects

Dr. Glen Muschio
Faculty Mentor
Digital Media

Peale's Museum Through the Eyes of a Visitor: Animation and Technology Bring History to Life

The renowned Independence Hall holds a lesser known past. From 1801 to 1827 it housed Charles Willson Peale's *Philadelphia Museum* combining art, science, and technology. Peale aimed to educate the republic's citizens in a time when there was little formal schooling. Inspired by Enlightenment ideals, Peale believed a democracy could only survive with an informed and virtuous citizenry. My project asks: How can we use both AI and traditional 3D animation to bring back Peale's Museum stories in a way that's both historically accurate and emotionally engaging?

Using, "Notes of a Visit to Philadelphia" by a Pennsylvania Moravian woman, I recreated an animation of her museum experience. State of the art text to video AI generators are presently inconsistent in the execution of prompts. To overcome AI shortcomings, I developed a workflow, in part, using digital assets created by past STAR scholars, refining them in Photoshop, and using them as references for AI video generation. Where necessary, I made manual animations.

This work is both a historical reconstruction and an exploration of technology's role in storytelling, showing how AI can speed production but still relies on human skill for accuracy and emotional depth.

Material Experimentation and Process Development: Integrating Creative Techniques into Concept-Driven Fashion Design

Anna Namur

Goodwin College of Professional Studies
First-Year Exploratory Studies

Prof. Danielle Claassen
Faculty Mentor
Fashion Design

My project began with the question: How can I use materials in interesting ways to make creative and functional fashion designs? My goal was to learn more about the materials and processes of fashion design and then use that knowledge to create final designs.

I started by finding inspiration, researching ideas and materials, and practicing figure drawing. With the help of my advisor, I revised my final drawings under a cohesive theme and chose techniques for each dress. I then learned about the process of pattern making- making slopers, draping on a mannequin, and making adjustments to my practice muslins. With experimentation I made three final dress patterns. The materials I used were beads, tulle, and pellon 541 (embroidery stabilizer). I used beads to resemble fruit/seeds, with pockets opening up to reveal the inside of the fruit. I used pellon 541 to make an embroidered map of Philadelphia, which I then layered on top of fabric. Lastly, I layered tulle to make a sliding curtain and windows, with each windowpane featuring different wildflowers in PA. Through this project, I was able to learn about the process of fashion design as a beginner, and create artistic, concept-driven dresses that will inspire my future work.

Trace A. Cassidy

Antoinette Westphal College of Media Arts & Design
Music Industry

Prof. Brendan Monahan
Faculty Mentor
Music Industry

Creating an Online Resource for the Music Industry Program

Audio is an integral part of modern society and media today. It encompasses numerous aspects of pop culture, and we rely on it for everything from long-distance communication to listening to music. Yet, whether you're a professional or someone on a phone call, there is one indisputable consistency: everyone hates when audio does not work. It's difficult to understand and seemingly impossible to fix. Consequently, my research focused on developing a public, online resource for the Music Industry program with three main goals: to simplify, centralize, and summarize information for students and anyone interested in audio. In pursuing the Music Industry Program, my cohort was given access to exclusive and expensive audio equipment largely inaccessible otherwise. It is an opportunity to use "the real thing" and gain valuable experience operating high-end audio gear. However, this introduced a steep learning curve that all students struggle to overcome. As a result, just as audio issues can quickly derail an online meeting, they can waste valuable time in a studio session. This resource would not substitute the Music Industry Program curriculum; rather, it supplements learning as a reference guide that protects students and equipment.

Biomimicry in Textile Construction: Tactile Engagement to Improve Inhibitory Control in Young Adults

Eva Farbman

Antoinette Westphal College of Media Arts & Design
Product Design

Prof. Michael Glaser
Faculty Mentor
Product Design

Mindless virtual interactions contribute to a feeling of passivity, leaving many young adults dissatisfied. Research shows that physical movement, reconnection with culture, and exploring nature can help alleviate this feeling. Can these techniques be integrated into a busy schedule? My research explores how the applications of lesser-known adaptations via biomimetics of textiles can add meaningful and engaging tactile engagement.

Coleopteran Elytra (hardened forewings) evolved to absorb impact through sclerotization, a biochemical process that forms the exoskeleton. Pattern found in the window-like indentations in the elytron of the Reticulated Beetle (Tenomerga Cinerea), a less researched species found in North America piqued my interest. Its colors and indentations that camouflage into decaying wood, has potential to connect the user of the textile to the details of life that otherwise go unseen.

Referencing SEM scans, I created pattern and surface texture to enliven the insect through fabric. I used an iterative design process consisting of trials of embroidery on mesh fabric to mimic texture, music wire (0.64 mm) to replicate venation, and a PVA glue mixture to simulate sclerotization.

Chi Nguyen

Antoinette Westphal College of Media Arts & Design
Product Design

Prof. Michael Glaser
Faculty Mentor
Product Design

Bee-a-Reader: Designing Better Braille Learning Tools to Raise Literacy in Visually Impaired Children

When I saw how hard my visually impaired classmates worked to learn Braille in primary school, I realized it is more than just reading to them—it is a pathway to literacy, independence, and dignity. Yet many struggled for years, not from lack of ability, but because the systems around them were not designed for their needs. Few tools can help blind children learn Braille effectively, and those that exist are often overpriced or poorly designed. Addition to the rise of audio-based assistive technology, this has fueled a global decline in Braille literacy and a higher unemployment in the blind community.

My project, ***Bee-a-Reader,*** aims to change this. Inspired by the hardworking bee, it is an interactive Braille learning tool that is tactile, playful, and age-appropriate for children aged five and up. Opening each cell reveals an object tied to a letter, turning this into a moment of excitement and discovery for young Braille learners. Using a user-centered design approach, I am researching, interviewing educators, collaborating with users, and prototyping iteratively to make Braille learning engaging, intuitive, and empowering. My goal is to give every child the chance to be seen, to learn with joy, and to shape their own future.

The Call: The Dangers of Cults on Individual Freedom

Alina Hernandez

Antoinette Westphal College of Media Arts & Design
Screenwriting & Playwriting

Prof. Matthew Kaufhold
Faculty Mentor
Screenwriting and Playwriting

Cults have a stronghold on unsuspecting people through psychological tactics and hierarchal planning. These include developing a strict set of beliefs required for followers and power held by a singular, messianic leader. Consequences for disobedience can range from harsh to dangerous for victims who go against the cult, leading members to feeling immense anxiety and dependence on others. Considering this, how can these elements serve as the backbone of a potential horror film?

The Call is a feature-length film screenplay about Mildred Stevens and her attempts to escape a cult, called Friends of the Sun, while getting help from town outsiders she makes friends with. For my research, I read through books and watched docuseries and video essays about group-thinking and individuals' experiences with cults. I also established my own creative process for going about my work by making a story outline with the help of my mentor and gaining inspiration from other works of film.

Sofiya Snitko

Bennett S. LeBow College of Business
International Business

Prof. John B. Henderson Jr.
Faculty Mentor

Evaluating Marketing Attribution Models: Implications for Channel Valuation and Strategic Decision-Making.

Inaccurate marketing attribution can lead to wasted budgets and missed opportunities. This project examines how attribution model selection influences channel valuation and strategic decisions. Using both simulated e-commerce data (Google Analytics Demo Store, UCI Online Retail) and platform-specific datasets (Meta Ads Sandbox), three models-Linear, Time-Decay, and Markov Chain-were applied to evaluate credit distribution across customer touchpoints. While Linear assigns equal weight to all interactions and Time-Decay emphasizes recency, the Markov model uncovered hidden assisting roles for channels like email and organic social. These differences significantly altered optimal budget allocation and campaign priorities. This comparison not only informs marketing strategy but also advances the broader field of data-driven decision-making in digital commerce, providing marketers with a practical framework to align attribution methodology with campaign goals and maximize return on investment.

The Bidding War for Business: A Deep Dive into State Incentive Deals

Peter C. Carey

Bennett S. LeBow College of Business
Accounting, Finance

Prof. Jonathan A. Liss
Faculty Mentor
Accounting

This project explores the competition among states to attract businesses with targeted tax incentives and non-tax incentives. These deals are usually marketed as a win-win that will create jobs and boost local economies, but the results sometimes fall short.

I examine the most common tools that states use, ranging from job creation tax credits to non-tax incentives, such as fast-tracking permitting. I then survey how states ensure that companies follow through on their commitments, using tools like clawback provisions or performance-based programs.

The focus of the project is the Amazon HQ2 bidding frenzy, where 238 cities responded to Amazon's RFP. Virginia won with a shrewd, long-term approach: it tied incentives to actual job creation, invested in public transit and computer science education, assuring that the community would benefit. Meanwhile, the New York deal fell apart due to public backlash and distrust regarding how the deal was struck.

This project also takes the bigger picture into account. Are these incentive deals truly fair? Do they produce lasting gains? I leave you with some thoughts on other ways states might invest, including paying companies to stay, directing benefits more fairly, and prioritizing real growth.

Aitzaz Aslam Khan

Bennett S. LeBow College of Business
Accounting, Finance, Business Analytics

Prof. Jonathan A. Liss
Faculty Mentor
Accounting

OECD Pillar Two: Assessing Its Impact on Global Tax Avoidance and Geopolitical Consequences

This study evaluates the Organization for Economic Cooperation and Development's (OECD's) Pillar Two, a 15% global minimum tax for large multinational corporations (MNCs), and its ability to close the $150-220 billion annual gap from profit shifting. Drawing on OECD, IMF, and case study data on U.S. tech giants, EU IP-heavy firms, Asian financial hubs, and developing economies, results indicate under-taxed profits could fall ~80%, with the steepest increases in effective tax rates for aggressive planners. Low-tax hubs like Singapore and Luxembourg are enacting domestic top-up taxes to retain revenue, while high-tax jurisdictions see limited changes. For developing nations, adoption could unlock vital public funds, but weak capacity, restrictive treaties, and investment agreements risk diverting gains to richer countries. MNCs are responding by realigning IP, restructuring financing, consolidating operations, boosting compliance systems, and exploiting carve-outs. Pillar Two will not end tax competition, but it sets a historic floor, makes havens far less viable, and nudges global investment toward locations with genuine economic activity, shifting taxation to greater equity and long-term stability.

The Effect of the China Shock on the Upward Mobility of Children Born between 1978 and 1992

Nana Kwasi Adu-Marfo

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Economics and Data Science

Dr. Andre Kurmann
Faculty Mentor
Economics

Over the last two decades, the rapid rise of Chinese import competition, popularly known as the "China Shock", resulted in a quarter of all US manufacturing job losses. Economic literature highlights the adverse effect of this shock on the US labor market. However, less attention has been paid to its effect on children's ability to improve their living outcomes. This research examines whether children born between 1978-1992 in more Chinese imports exposed regions faced lower chances of improving their living outcomes. To assess this, we merge changes in child individual income from 1978-1992, measured as upward mobility, from the Opportunity Atlas dataset with Chinese import penetration index data developed by economists Autor, Dorn, and Hanson, which estimates trade exposure from 1990-2007 across commuting zones. We then run OLS regressions to assess how trade exposure influenced changes in upward mobility for children. Results show that most areas exposed to the "China Shock" saw upward mobility gains; however, low-income whites saw persistent low upward mobility. This suggests that low-income whites did not recover as well from the "China shock". Understanding such patterns is crucial to creating policies that benefit all groups.

Jaden Stahl

Bennett S. LeBow College of Business
Finance, Accounting

Dr. David Becher
Faculty Mentor
Finance

When the Streets Move the Markets: The Impact of Nationwide Protests on Investment Banks

Investment banks play a primary role in capital allocation, innovation, and economic growth, and therefore, may be exposed to disruptions in financial decision-making. While protests are non-financial events, their potential to disrupt local economies, investor confidence, and operational stability can influence banks' economic and strategic decisions.

This study examines whether nationwide protests alter investment banks' financial policies and market performance. Using data from 2017–2024, we compare banks headquartered in protest-heavy regions with those in more stable areas across capital expenditures, cash holdings, market value, returns, and cash flow volatility—factors that capture investment activity and financial stability. We hypothesize that banks more exposed to social unrest respond defensively, prioritizing liquidity over growth and experiencing greater market strain.

Consistent with these expectations, highly exposed banks decrease capital expenditures more sharply than less exposed peers during protest waves, hold significantly more cash, suffer larger market value losses, and see greater increases in cash flow volatility—indicating that protests impact banks through heightened operating and financial uncertainty.

Token Characteristics and ICO Performance

Ryan Widjaja

College of Computing & Informatics
Computer Science

Dr. David Becher
Faculty Mentor
Finance

Melissa Crumling
Co-Mentor

Over the past decade, a new form of financing, initial coin offering (ICO), has emerged, fueled by developments in blockchain technology and its uses. Components of the token offerings vary widely across crypto firms, combining both debt and equity-like characteristics. Equity-like properties may include market-determined token pricing, goal size (raising growth capital without obligation to repay), and differentiating token roles such as profit participation or governance voting. Debt-like properties may include fixed or predetermined token pricing and limited token sale availability. Using a sample of 12,381 cryptocurrencies from Crunchbase and Kaggle, I aim to understand which token offering components are associated with higher ICO success rates, measured by the percentage of the funding goal achieved. Using OLS regressions, I aim to measure which factors influence ICO success to better understand if equity-like or debt-like features lead to higher success or investor participation, or if token-based offerings operate under hybrid instruments. These results will contribute to the ongoing regulatory discussion regarding the classification of crypto, and how investors can think of them under traditional finance systems.

Sophia Adriana Egoavil

Bennett S. LeBow College of Business
Finance

Dr. David Becher
Faculty Mentor
Finance

From Streets to Stocks: Can Protests Shake Wealth Management Firms?

In recent years, the U.S has seen a rise in various types of protests, ranging from political to racial, impacting the performance and decisions of firms. As these firms rely on stable market conditions, investor confidence, and portfolio performance, they may experience changes in their financial metrics in response to such events. Protests highlight social concerns, draw media attention, and pressure corporations to respond. Political and racial protests, in particular, likely have more immediate effects on firms relative to other protest types, triggering uncertainty in tax policies and investment strategies, as well as influencing reputation risks and reshaping client expectations. In addition, other protests may affect firms over time rather than causing immediate shifts. Wealth Management firms are important to study as they bridge the financial markets and client relationships, making them sensitive to shifts in public opinion, policy changes, and reputational impact. To assess whether protest type influences outcomes, I analyze changes in the market value, profitability, and ownership of Wealth Management firms, and expect that political and racial protests have a stronger and immediate impact on these financial firms.

Decoding Success: Critical Factors in Equity Crowdfunding Performance

Ashish Ronak

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Business Analytics, Management Information Systems

Dr. David Becher
Faculty Mentor
Finance

Melissa Crumling
Co-Mentor

Over the past decade, equity crowdfunding has become a major source of startup financing, enabling founders to raise capital directly from individual investors online. Campaign performance varies widely, reflecting differences in financial health, investor formation, and engagement. I analyze approximately 200 WeFunder campaigns in this project, collecting metrics such as revenue, net profit/loss, and funding raised. Afterwards, I examine the correlations between these variables and success measures, such as the percentage of funding goals achieved. Results show that campaigns with net losses can still excel in revenue growth, as these losses are often campaigns strategically betting on the future market dominance of their product. Angel or VC investment is also linked to exceeding fundraising targets, as their backing signals credibility and attracts other investors. Additionally, higher social media engagement positively correlates with deal success by allowing founders to showcase themselves, build trust, and connect personally with backers. These insights can help founders design stronger campaigns and guide investors toward promising opportunities.

William Barry

Bennett S. LeBow College of Business
Finance

Dr. Greg Nini
Faculty Mentor
Finance

Derevianko Sacha
Co-Mentor

AI Integration in CPG: An Analysis of Hiring Trends and Firm Size

As a reaction to the rapid expansion of AI and its influence across industries, new jobs opened and hiring increased. My project, developed under the STAR Scholars program, explores the integration of AI in consumer packaged goods companies and examines both current practices and potential future trends.

The rapid improvement in AI, from general applications like OpenAI to firm-specific patented systems, requires employees with specific talents to best develop and use the technology. My project investigates how much companies spend on AI talent. I focus on the consumer packaged goods (CPG) industry and research 30 of the largest publicly traded companies listed on the U.S. stock exchange. I collect data from company websites on every job opening and search for mentions of AI to determine if the role is AI related and what type of AI is used. With this data, I calculate the proportion of AI-focused jobs to total jobs for each company.

This data provides a foundation to study whether firms of different sizes spend more on AI. I expect larger firms to have more resources to invest, showing up as a higher percentage of AI-focused jobs. The main hypothesis is that larger firms invest more into AI to remain competitive and innovative.

How Producer Hierarchy Affects Financial and Creative Success for Startup Film Studios

Alexander Nicholas Bogey

Bennett S. LeBow College of Business
Finance

Dr. Dali Ma
Faculty Mentor
Management

One of the most critical aspects of every business lies within its organizational structure. From the smallest startups to Fortune 500 companies, having an efficient organizational system increases productivity, profit, and longevity. Recently, many startups claim that "tall" structures with multiple management levels hinder efficiency. Instead, they favor "flat" structures with minimal or no management levels, despite some professionals advising for keeping hierarchies. To test the effectiveness of both structures, this project analyzes film production startups and the role producer hierarchies play in their success.

The IMDbPro database presents the opportunity to examine studios' earliest films, along with their budget, gross profit, producer data, and quality rating. After taking a random sample from the population of American production startups from 1995 to the present day, we can compare the producer hierarchy with their commercial and creative success. The resulting analysis will provide insights for improving the startup organizational structure by presenting an answer to the flat vs. tall structure debate. Also, this project will discover the best parameters for balancing profitability with the quality of creative projects.

Oowarae Alexander

Bennett S. LeBow College of Business
Management Information Systems

Dr. Elea McDonell-Feit
Faculty Mentor
Marketing

Alexa Schlyfestone
Co-Mentor

Emotions Lab

In this project, we developed a laboratory procedure for passively recording the emotions expressed by a user while watching a video. Participants view short videos while their facial expressions are recorded, and these recordings are analyzed using PyFeat, a Python library for automated facial expression recognition based on the work of psychologist Paul Ekman. PyFeat scores the video for expressed emotions including anger, disgust, fear, happiness, sadness, and surprise. This lab procedure can be used to evaluate the emotional impact of different types of video content. We piloted this procedure using video designed to evoke schadenfreude and assess the accuracy of the emotion recognition software. The procedure will be used in a broader research investigating whether social media content which effectively captures attention also increases anxiety in users.

Analyzing the Educational Outcomes of Smartphone Restriction Policies in Pennsylvania Schools

The presence of cellphones in schools and its effects on student academic performances are pressing concerns in current education policy. In 2024, Pennsylvania dedicated $100 million dollars towards a grant program that provides lockable pouches to restrict cellphone use during school hours. Yet the effectiveness of this policy remains unclear. This research examines whether the policy results in changes to educational outcomes. To do so, we compare Washington School District, which adopted the lockable pouches in the 2022 school year with ten similar Pennsylvania school districts without the policy. The schools were matched to Washington based on similar socioeconomic, demographic, and pre-treatment test scores. The Difference-in-Differences (DiD) method was applied on standardized test scores from each district between 2015 to 2024, measuring the effect of the cellphone policy on student performance outcomes. Results show no significant evidence of change in Algebra I scores, and incidentally weak evidence of declines in Biology and Literature scores. Overall, our results suggest that the cellphone policy has not yet shown measurable effects on academic performance, while its longer-term effects remain to be seen.

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Framing Health: Behind Sugar Content Labels?

The prevalence of health-conscious individuals in society has grown significantly over the past decade. As more people consider the healthiness of their food choices, reduced-sugar products have become increasingly popular. This study examines how label framing (i.e., "zero sugar" versus "no sugar") affects consumer perceptions and behaviors using a one-factor, between-subjects experimental design. Results indicate that less (more) health-conscious individuals perceive a product with a "no sugar" ("zero sugar") label as healthier, which in turn leads to a higher purchase intention. This perception may stem from the definitive nature of the term "zero," which more strongly conveys that the product does not contain any sugar. The findings suggest that consumers' responses to food labels are strongly influenced by their level of health consciousness. Businesses—particularly marketers—can leverage this insight to more effectively target consumers with varying degrees of health consciousness through strategic language choice in packaging and advertising.

FIFA Club World Cup and Equity in Global Soccer

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This project investigates the extent to which the FIFA Club World Cup has increased publicity for smaller market clubs through marketing initiatives that promote equality in world football. I used a multi-method design where I collected both qualitative and quantitative data, but analyzed them separately. I interviewed FIFA volunteers, reviewed international media coverage, and analyzed FIFA's social media marketing. The findings suggest that although smaller-market teams gained exposure and financial benefits, FIFA marketing focused mainly on larger-market teams and players. Most of FIFA's advertisements in the lead-up to the tournament focused on European clubs such as Real Madrid and Chelsea and players such as Messi. Smaller market teams like Auckland City and Mamelodi Sundowns were barely included in early campaigns. They only became part of the story once matches started and results came in. From the interviews and observations, most fans at the games were international. Volunteers said local turnout was low, as expected. Overall, the tournament gave smaller-market teams with a rare opportunity for global exposure, but FIFA's marketing efforts were an afterthought rather than a priority.

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Growing Climate Resilience in Urban Areas

In the 1970's, community gardening expanded across U.S. cities as Black activists, shaped by the Civil Rights Movement and earlier resistance efforts, reclaimed vacant neighborhood lots to build back power after disinvestment, environmental injustices, and extractive development severely disrupted residents' daily lives. These gardens impacted local organizing, increased food sovereignty, and improved ecological health. Yet, their removal was continuously threatened by "urban renewal" efforts. This project is only a small-scale investigation into this complex topic, focusing on two West Philadelphia community gardens as a case study, Dornsife and Summer Winter. The study measures local impact, ecological health, and gardeners' perceptions of urban development pressures. Methods included surveys, interviews, ecological analysis, and a literature review. Surveys explored perceptions of the benefits, challenges, and longevity of the garden. Ecological analysis documented biodiversity and soil conditions. Analysis finds community gardens improve food access, community ties, and ecological health. Land stewardship feels uncertain for many residents, highlighting the need to protect these spaces as valuable community resources.

Genomics of the Common Urban Lichens *Physcia millegrana* and *P. stellaris*

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Lichens are a complex life form mainly comprised of a symbiotic relationship between algae and a fungus. Lichens can be found growing on trees, rocks, or urban infrastructure. Despite urban stressors, lichens can adapt to city environments. Studying lichen genomes can provide a deeper understanding of their coordination with other microbes and how factors, like the mating system, can help them survive in urban areas. This project includes field work of collecting lichens around the Philadelphia area. DNA was then extracted from the collected samples with lab work. DNA sequences from the lichen samples were processed using various bioinformatic programs like filtlong, fastqc, and flye. The fungal genome of two lichens were assembled by identifying overlapping sequences and identifying different organisms within the lichen. The assembled genomes were then checked for completeness with a reference set of fungal genes. Bioinformatics was also used to search for MAT genes that influence the mating system of the lichen. This project is part of a larger effort to understand how lichens survive and thrive in stressful urban environments.

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Ecological Study on the Effects of Seabird Predation on Fiddler Crab Behavior

There has been an evident decline in global biodiversity over the last century, which has resulted in cascading effects on many ecosystems. The salt marsh of Barnegat Bay in Waretown, NJ has experienced similar effects, with a decline in native seabird populations; these seabirds predate heavily on fiddler crabs (*Minuca pugnax*), which are prominent scavengers within salt marshes and manipulate the environment through the creation of burrows and sediment bioturbation. The objective of this project was to observe whether declining seabird populations significantly affect the burrowing behavior and population density of fiddler crabs in the NJ salt marsh. For this experiment, we created 5 plots, and 4 different treatments within each plot. Each treatment was equal in size and separated by decreased crab density, decreased bird presence, decreased crab and bird density, and an ambient control treatment. We conducted a count of burrow density and a CPUE experiment within every treatment; additionally, we set up field cameras to record various plots and performed a tethering experiment to observe direct seabird behavior and how readily crabs were consumed within every treatment.

Influence of Watershed Characteristics on Sediment Transport Patterns in Urban Streams

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This study explores how watershed characteristics may influence patterns of sediment transport during storm events in two urban streams. Automated ISCO samplers were used to collect water samples during high-flow periods, which were analyzed for suspended sediment concentration (SSC) alongside discharge measurements. These data were evaluated to identify patterns in how sediment concentrations change throughout storm events. Spatial information on watershed features, including terrain and surface conditions, was compiled from publicly available mapping resources to provide context for interpreting sediment–flow relationships. By examining multiple storm events and both stream locations, this research investigates how physical and environmental differences between watersheds might shape sediment transport responses. The results will help improve understanding of sediment movement in urban streams and how it relates to watershed characteristics.

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Analysis of Museum Specimens and Community Science Images Reveals Patterns of Geographic Variation in the Versicolored Barbet

Neotropical mountains house a disproportionate number of avian species, but the ultimate causes of this pattern are unclear. One possibility is that montane organisms occupy different climatic niches at different elevations on the same mountain, and thus global climate changes may drive cycles of isolation and connection between montane populations over time, both driving and limiting diversification and speciation. The analysis of geographic variation in widespread species is ideal for testing the drivers of tropical montane speciation. I used digital imaging, community science images, and morphometric analysis of museum specimens to map the geographic limits and geographic variation in the Versicolored Barbet (*Eubucco versicolor*). The Versicolored Barbet is native to the eastern slope of the Andes mountains and is geographically variable in coloration among its subspecies. I tested whether plumage color variation may have evolved via adaptation to abiotic factors such as temperature and precipitation or via other evolutionary forces such as mate choice. I identified multiple hybrid populations from community science images and compared color measurements of these images with standardized quantifiable photos of museum specimens.

Metabolic Stress Decreases GCH1 Protein Levels in SH-SY5Y Cells: Implications for Tetrahydrobiopterin (BH4)-Linked Neurological Disorders

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Tetrahydrobiopterin (BH4) is a crucial cofactor for hydroxylase enzymes required in the biosynthesis of neurotransmitters, including the dopamine family, serotonin and nitric oxide. It is also involved in the regulation of redox homeostasis and cell signaling. BH4 deficiency has been implicated in neurodegenerative disorders such as Alzheimer's and Parkinson's diseases, as well as mental illness. GTP cyclohydrolase 1 (GCH1) is the rate-limiting enzyme in BH4 biosynthesis. The aging vascular system is often associated with ischemia, leading to nutrient deprivation and metabolic stress. However, how ischemia-related stress affects BH4 levels remains unclear. We hypothesize that metabolic stress alters GCH1 expression and function, contributing to BH4 deficiency. To test this hypothesis, we tracked the GCH1 protein levels in the SH-SY5Y neuroblastoma cells, which were treated under no glutamine, no glucose, and hypoxia conditions for 18 hours. Western blotting revealed that GCH1 protein levels decreased in all stressful conditions, and glutamine depletion caused the most decrease. These preliminary findings suggest that ischemia-associated metabolic stress may impair the GCH1 expression, hence resulting in BH4 deficiency.

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Designing a Device for Semiconductor Photo Sensing Using Phosphorus-Based Nanomaterials

Low-dimensional phosphorus-based nanomaterials, particularly Phosphorus Metal Halides (PMHs) single crystals, have demonstrated promising electronic and optoelectronic properties for next-generation semiconductor devices. Despite their potential, practical applications remain limited—primarily due to the lack of well-defined device architectures and insufficient studies on their behavior under light exposure. This study aims to investigate the electronic and photo responsive properties of PMH by developing a photosensing device. Understanding how PMH responds to different wavelengths of light can provide valuable insight into its potential for optoelectronic applications. A photosensing circuit was designed using a PMH single-wire crystal mounted on a gold-coated Si/SiO2 wafer substrate. A dual-channel Keithley source-meter was used to apply controlled voltages to the gate, source, and drain terminals. The device was tested under a broad range of visible light wavelengths (400 to 700nm) and near-infrared light (up to 850 nm) to evaluate its photoresponse. Light sensors were used to monitor variables such as IR, Luminous Flux and distance. Current-voltage (I-V) measurements were recorded in both illuminated and dark conditions.

Bad Religion? Rethinking the Unrequited Love between Islamic Feminism and Care Ethics on Sexual Agency

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Western academia frames Islam as a "bad religion": an inherently patriarchal faith that denies women their agency in all aspects of life. Even care ethics—one of the most pluralistic Western moral theories—often overlooks Islam, fostering a sense of unrequited love between the two. Islamic feminism as a scholarly and social movement has recently begun to gain traction, however, creating opportunities for the reclamation of sexual agency for Muslim women. I argue that the commonality of feminism forms the foundation for comparative exploration of Islamic feminism and care theory in their approaches to sexual agency. Examining sexual agency in Islam is crucial because while the faith is unfairly demonized by the West, many Muslimat do face constrained experiences of agency, shaped by limited education and cultural norms that discourage critical engagement. As an intersectionally oriented perspective, care ethics may offer reflection and reconciliation for Islamic feminism. Through a literature review of both fields, I construct a nuanced picture of how they understand agency. While feminism underpins this project, I contend that it also functions as cupid, reigniting the conversation between Islamic feminism and care ethics.

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Our Republic vs. Plato's *Republic*: What Does Plato's *Republic* Tell Us About Justice In America Today?

Today, as the United States of America undergoes rapid change under a new presidential administration and a new political landscape, Plato's *Republic* provokes modern American readers to consider the actions of their government: Is this what justice looks like? Plato's *Republic*, one of the most influential and foundational texts of political philosophy, discusses the questions of what justice is, what just societies and just individuals look like, and what the ideal government looks like. Many themes and concerns voiced in Republic remain just as relevant to modern American readers as they were to the Ancient Athenians: speaking truth to power, the role of truth in society, and the influence of human desires on governance and justice. These timeless ideas, originally posed in pursuit of justice, appear especially relevant today as the American president has promised that "The scales of justice will be rebalanced." This research synthesizes a reading of the *Republic* in the school of Continental Philosophy and an analysis of current events in American Politics. Ultimately, I argue that the United States of America is making governing errors, outlined in the *Republic*, that prevent the establishment and realization of a just society.

Learning Within Philadelphia Foodway Networks, In Support of Las Mujeres de Maíz

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Inside Philadelphia's immigrant communities, women are at the forefront of safeguarding culture, through culinary practices and community agriculture. This effort is necessary because movement into foreign communities separates immigrants from their home communities and indigenous foodways. However, such effort is only occasionally recognized, due to small public interest and insufficient resources. Therefore, to support visibility and long-term sustainability, it is important to prioritize representation and cultural care over commercialism; individuals with claim to indigenous foodways should be advocates of their own culture. Throughout this project, we worked alongside Las Mujeres de Maíz, a group of Mexican and Central American women who preserve and share the cultural, culinary, and environmental importance of maíz (corn) and collective power building. My particular role in this project was focused on Philadelphia's foodway networks, led by a diversity of community members upholding culturally-rooted food-security initiatives. As a result, I built relationships and learned community development skills, utilizing my new understandings to support Las Mujeres de Maíz and their preservation of indigenous foodways.

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Simulation of Waves in Heterogeneous FPUT Lattices

The Fermi–Pasta–Ulam–Tsingou (FPUT) lattice models nonlinear wave propagation in coupled oscillators, revealing complex dispersive and nonlinear interactions. We study the diatomic FPUT lattice with periodic boundary conditions, where alternating masses are connected by identical nonlinear springs. Initial conditions are inspired by the Korteweg–de Vries (KdV) soliton profile, scaled by a small parameter ε, enabling comparison with continuum predictions. A fully vectorized fourth-order Runge–Kutta (RK4) scheme is implemented to simulate relative displacements and velocities efficiently, reducing memory overhead and improving computational speed. We examine how waveforms evolve over time, tracking solitary wave persistence, interaction, and eventual dispersive decay. By varying ε and measuring the deviation between discrete FPUT and analytical KdV solutions, we compute empirical convergence rates and investigate the onset of scattering effects. The results illustrate the strong agreement with KdV theory in the small-amplitude, long-wavelength regime, while capturing deviations due to lattice discreteness.

Decoding DUNE's Particle Beam Monitoring System

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The Deep Underground Neutrino Experiment (DUNE) investigates neutrino oscillations. Neutrinos are very small, nearly massless elementary particles that are incredibly hard to detect but might provide crucial information on topics like the origin of matter in the universe. The DUNE experiment uses a high-energy proton beam which interacts with a target and produces hadrons, subatomic particles, which then decay into pairs of muons and neutrinos. Muons are another type of elementary particle but are much easier to detect than neutrinos. My work focuses on three systems each designed to detect muons and hadrons along the beamline. By analyzing what each system can and cannot record, the project highlights their strengths and limitations. HADeS excels at hadron detection, MuMS specializes in high energy muon tracking, and MARGARITA covers low energy muons and determines their electric charge. Comparing these systems reveals where they complement each other and where gaps remain. These findings help guide decisions about which systems to include in the DUNE beamline, aiming to improve data quality and improve our understanding of the beamline throughout the experiment.

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Refining Software for Hadron Production Detectors

The neutrino is an abundant subatomic particle that has no charge and little mass. This makes it challenging to study. Understanding the properties of the neutrino can provide insight on the differences between antimatter and matter. The neutrino can be studied using a neutrino beam, done at experiments like DUNE (Deep Underground Neutrino Experiment). High-energy protons are accelerated into a target, releasing unstable charged particles called hadrons that are directed to create a hadron beam that then decays into a neutrino beam. Understanding the properties of the neutrino beam is limited by uncertainty in the production of hadrons in the target. The EMPHATIC project (Experiment to Measure the Production of Hadrons At a Test Beam In Chicagoland) addresses this uncertainty in neutrino beam measurements by characterizing and analyzing hadron beam production using a variety of detectors at a test beam at Fermi National Accelerator Laboratory. My research helps refine the hadron decay predictions essential for neutrino-based experiments by monitoring the detector data system in real-time. I expanded the capabilities of the monitoring software for current and future detectors.

Expanding a Laser Photolysis Spectroscopy System with Modulated Excitation to Study Hemoglobin Polymerization

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Modulated excitation spectroscopy is a technique developed in this laboratory that is to measure the rates at which molecules bind to ligands. It has previously been used to measure hemoglobin concentration within polymers to determine whether Hb is in the tense or relaxed state. In this study, a new capability was added to an existing laser photolysis spectroscopy setup by integrating modulated excitation into its capabilities, creating a more versatile instrument for studying hemoglobin. The application is to determine to what extent hybrids form between nickel-substituted fetal hemoglobin (NiHbF) and sickle hemoglobin (HbS). Polymerization is triggered by a laser that removes carbon monoxide from HbS, and time-resolved spectroscopy is then used to detect the spectral signatures of NiHbF during polymer growth. This allows identification of specific hemoglobin types within complex polymerized structures and detection of the point at which hybrid molecules form. While this work applies the technique to a question related to fetal hemoglobin in sickle cell disease, the expanded instrumentation is expected to have many broader applications in studying molecular binding rates and structural changes in other hemoglobin variants.

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Estimating the Velocity Dispersion of Dark Energy Survey Year 3 Galaxies Using Weak Gravitational Lensing

Gravitational lensing has been a key method of constraining cosmological constants within the last century. Weak gravitational lensing is a subsection of this field, where statistical analysis is used on a large data set of potentially lensed objects. Galaxy-galaxy lensing refers to any system where a galaxy serves as both the source and the lens itself. Using data from year 3 of the Dark Energy Survey (DES Y3), we graph the radial flexion profile of a large number of galaxy-galaxy systems. Using a chi squared model, we fit the radial flexion profile of a singular isothermal sphere (SIS) to this data. Using the fitted model, we can estimate a velocity dispersion of 613.31 km/sec for the average galaxy in our data set.

Characterizing High-Altitude Cosmic Radiation

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High-Altitude Engineering for Research in Astrophysics (HERA) project investigates atmospheric cosmic radiation through high-altitude balloon flights reaching altitude of 100,000 feet. High energy cosmic particles bombard nuclei of the atmosphere producing cascades of secondary particles. Scintillator-based detectors record the flux of particles throughout the balloon flight. Several flights launched with diverse solar activities, like a coronal mass ejection (CME), are investigated in this experiment to see differences in the Regener-Pfotzer Maximum and the Forbush Decrease. Data is used to draw inference regarding particle energies with detector calibration. By working simultaneously in data analysis, detector and payload development along with coordinated launches, this project represents an advancement in the possibility of balloon-based cosmic ray measurements.

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Optimizing Deep Learning Models on FPGAs Using hls4ml

Fast radio bursts (FRBs) are brief explosions of radio waves emerging from deep space. Machine learning models can help detect fast radio bursts (FRBs) in radio data to capture high-time-resolution data from these events. However, since an FRB lasts only several milliseconds, these models need to produce inferences at rapid timescales. Field-programmable gate arrays (FPGAs) are hardware circuits that use customizable resources to efficiently execute different parts of a model simultaneously, thus achieving low-latency inference. Optimizing a deep learning model for FRB identification on FPGAs can allow for latencies below those of more common integrated circuits, including CPUs, GPUs, or TPUs. Quantization and pruning are effective techniques to compress model size for performance gains. This project uses hls4ml (Fahim et al., 2021), a tool that facilitates the conversion of machine learning models written in Python into FPGA firmware to support computational flow for low-latency inference.

Physics-Informed Neural Networks for Options Pricing in Stochastic Markets

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Partial Differential Equations (PDEs) describe the laws that govern systems everywhere from stellar mergers to the volatility of financial markets. This project bridges those extremes by applying machine learning to accelerate PDE-based modeling in computational physics and quantitative finance. I began by developing traditional numerical solvers using Runge–Kutta 4 methods as baselines. I then engineered a Physics-Informed Neural Network (PINN) to approximate solutions to the Black–Scholes PDE, a foundational equation for valuing European-style options, integrating the equation, initial and boundary conditions, and financial constraints into the loss function. The PINN achieved option pricing results within 1.0% of high-resolution numerical methods while running over 60× faster. Finally, I scaled the model to the more complex Heston PDE, a higher-dimensional, stochastic extension of Black–Scholes that is not easily solvable in closed form and cannot be efficiently handled by standard numerical methods without extensive transformations. These results underscore the potential for physics-based deep learning techniques to power faster, more accurate financial modeling, bringing tools from computational physics to the trading floor.

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Molecular Dynamics Simulation – Excitable Swarm

Molecular dynamics is a computational framework used to study the dynamics of particles. While traditionally applied to systems of atoms, its implementation in analysing interactive forces during the motion of cell-sized robots is novel. This research bridges molecular dynamics with the emerging field of micro robotics, exploring how miniature robots can be engineered to transport cargo to targeted locations while accounting for forces that arise during motion. Our study focuses on microrobots that behave as an excitable media, a dynamic system characterized by the propagation of nonlinear waves. We investigate spiral wave formations generated around a central cargo particle. This large cargo particle has ability to excite surrounding swarm particles, forming spiral patterns that facilitate directed transport. Autonomous directed transport of cargo at small scales could play a role in future medicine, advanced manufacturing, and self-repairing structural systems.

In our research study, we hypothesized that swarm density influences the size of spiral waves formed. Results confirmed this but revealed that, high density can also lead to self excited spirals which abandon the cargo, highlighting the need for an optimal density.

The Unseen Hand: Political Interests in the Shadows of Genocide

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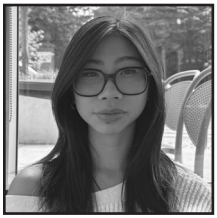
What political conditions precede genocide, and how do these conditions vary from other armed conflicts? Also, what criteria are used to classify an event as genocide under international law? Genocide is defined as acts of dehumanization committed against specific groups with the intent to destroy them. By exploring the causes of genocide, this study examines how and why certain atrocities are designated as genocide while others are not. This qualitative, comparative study analyzes case studies through UN reports, scholarly literature, and documentaries. It compares the Cambodian Genocide with the Bangladesh Liberation War, the Bosnian Genocide with the Kosovo Conflict, and the Rwandan Genocide with the First and Second Liberian Civil Wars. Consistent patterns in the lead-up to both types of conflict emerge, revealing that international political interests significantly influence genocide recognition despite the legal definition outlined in the UN Convention on the Prevention and Punishment of the Crime of Genocide. These insights suggest that early intervention may be possible by identifying similar signs. Future research should investigate recognition mechanisms and the long-term consequences of acknowledgment and denial.



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Shaping Creativity: Goal Orientation, Cognitive Flexibility, and Prefrontal Modulation via tDCS

Creativity, the ability to produce novel and useful ideas, has become a popular research focus due to its societal importance. In this project, we examine the effect of transcranial direct current stimulation (tDCS)—a noninvasive method using weak electrical currents to modulate brain activity—on cognitive flexibility. Although most creativity tasks emphasize bottom-up processes (building ideas from details), real-world problem solving also relies on top-down processing (applying prior knowledge) to achieve goals. To engage both types of processing, we pioneered a new task, the Alternative Objects Task (AOT), wherein participants are asked to satisfy goals with a common or an uncommon object. Here, participants complete the AOT while receiving excitatory (anodal), inhibitory (cathodal), or sham 4 × 1 high-definition tDCS at 1.5 mA over the left prefrontal cortex. This design tests how transient changes in neural activity affect problem-solving performance. Analyses of fluency, semantic distance, and reaction times show significant task- and stimulation-related differences, with cathodal tDCS enhancing and anodal tDCS reducing response generation, highlighting how goal orientation may shape prefrontal contributions to creativity.

Individual Differences in Brain Organization: A Network Science Approach

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The brain's wiring isn't random - it's organized as a network. This property of the brain provides researchers with a novel framework, known as network science, to investigate the properties of the brain that may influence cognition. In network science, brain regions are represented as "nodes" and the connections between them as "edges". Network science allows researchers to study the properties of a node, such as the number of edges it has. One critical property of the human brain is the cluster of highest degree nodes, often referred to as a "rich-club regime". The rich club regime facilitates efficient neural communication, and the loss of high-degree nodes due to brain injury is associated with behavioral deficits. While group data demonstrates the number of high-degree nodes, we do not understand how the frequency of these nodes differs across individuals. To examine this, we used neuroimaging data from 26 people to examine whether they had a rich-club regime. Across participants, we found a consistent rich club: most regions had few links, but a few key, highly connected regions recurred across individuals. Future work can use this research to examine how individual differences in the rich club regime relate to cognition.

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Sex Moderates the Relationship Between Trait Rumination and Ongoing Ruminative Thinking

Rumination involves repetitive thinking about negative feelings. Few studies have investigated the sex differences in trait rumination; recent research shows mixed findings. Researchers have yet to investigate whether the relationship between trait rumination and ongoing ruminative thinking covaries with sex. This project aims to replicate past findings on sex differences in trait rumination and explore whether trait rumination relates to ongoing rumination as a function of sex. Trait rumination was measured as Rumination Response Scale (RRS) scores, which was collected across four studies (N=194). Ongoing rumination was measured using the experience sampling method in an in-laboratory mind-wandering task across two studies (N=90). Results from Wilcoxon rank-sum tests revealed no significant sex differences in RRS scores. A linear regression model revealed that RRS scores were significantly positively associated with experience-sampled rumination ratings, and that this effect was stronger for males than for females. Possible explanations include the limited availability of emotional outlets for males, which may contribute to a more static emotional state. Future research should ensure equal representation of males and females.

Integrating Deicide into an Architecture Analysis Tool for Strategic Refactoring of God Classes

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Large "God classes" (10K+ LOC) are a persistent challenge in software development, severely reducing maintainability and scalability. While the DV8 architecture analysis suite detects technical debt and visualizes architectural anti-patterns formed by dependencies among files, it lacks capabilities for fine-grained inner-file class decomposition. We extend DV8 by integrating Deicide, a state-of-the-art complex class decomposition algorithm that holistically clusters entities within a complex class into cohesive responsibility modules using structural, semantic, and client-dependency relations. We adapted Deicide's output for DV8's visual analytics, redesigned the GUI for improved decomposition planning, and iteratively refined the prototype. This integration enables developers to visualize and strategically plan the refactoring of God classes, producing smaller, independent classes with minimal external impact. Our approach has the potential to be integrated with an IDE or within CI/CD pipelines, offering an automated safeguard against technical debt accumulation.

Keywords: God class, software refactoring, technical debt, class decomposition, software visualization

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Solving Large Linear Systems Efficiently: Applying Early Termination in Wiedemann's Algorithm

This project explores Wiedemann's algorithm for solving large sparse linear systems over a finite field. Wiedemann's method (1986) probabilistically computes the minimal polynomial over finite fields using the Berlekamp–Massey (BM) algorithm to find the recurrence of Krylov sequences.

Eberly (2003) proposed an early termination criterion for BM: For matrix size n and field order q , if a recurrence holds for $c \cdot \log_q(n)$ consecutive terms without change, the algorithm may stop early. This can significantly reduce runtime, but may fail.

This project studies the empirical success rate of early-terminated BM across matrix types, sizes, and field orders. For $c = 3$, results show >98% success across test cases. Diagonal and sparse matrices terminate the earliest, while Toeplitz, Jordan, and companion matrices typically require full BM. Thus, early-terminated BM can be combined with Wiedemann with high confidence, and specific success rates for each matrix type can guide combination strategies to ensure fast and precise solutions in large, sparse linear systems.

Identifying True Causal Effects in ML: A Comparative Study of Predictive and Causal Methods

Artificial Intelligence (AI) models are widely used for prediction but often confuse correlation with causation, leading to misleading conclusions. This research examines the distinction between predictive machine learning (ML) and causal inference methods using the example of shark attacks and ice cream sales, which exhibit a strong correlation but no causal relationship. Employing linear regression for predictive ML suggests a strong association; however, applying causal inference techniques with the DoWhy library to control for confounders such as temperature and beach attendance reveals no causal effect. The study highlights the limitations of predictive models in identifying true causal relationships and emphasizes the importance of integrating causal reasoning and human judgment to enhance the reliability, transparency, and safety of AI-driven decision-making across critical domains like healthcare, finance, and public policy. Building on this work, future research will apply these methods to real-world datasets, with a focus on modeling the causal effects of economic sanctions.

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Efficient context retention in LLMs: an alternative to in-context memory

Large Language Models (LLMs) face significant computational challenges with large context windows for maintaining conversational memory, vital for domain-specific tasks. This approach is computationally expensive, requiring re-processing of the entire conversational history with every turn, making true long-term memory inefficient. Our research introduces a new methodology: creating efficient, context-aware agents by training smaller models for complete data internalization.

This approach leverages the nanoGPT architecture, training a 12-layer, 124-million-parameter model from scratch on the MMLU benchmark, a diverse collection of academic questions. The model was trained for perfect memorization, explicitly forced to internalize the entire dataset by achieving near-zero training loss. Model performance is evaluated on its ability to perfectly recall information from its domain. Preliminary results suggest near-100% accuracy on recall tasks. This indicates the potential for creating a fleet of specialized, computationally efficient expert models, each with a perfectly internalized knowledge base, offering a scalable and practical alternative to today's resource-intensive context windows.

Confidence Calibration in Large Language Models: Affecting Calibration with Conditional Weight Updates

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Large Language Models (LLMs) are widely used for text generation, chatbots, and question-answering—but how trustworthy are they? Trust requires knowing a model's accuracy as well as managing its confidence, especially in grey areas like ethics and politics, which may require more tentative responses.

Current fine-tuning (FT) methods lack this control, partly because they fail to account for the fact that repeated exposure to a fact does not make it more correct. We propose a revised FT method that updates model weights only when the model does not sufficiently "know" an answer.

We fine-tuned Meta's Llama-3.2, 1B parameter model on the MMLU multiple-choice dataset using traditional FT methods for a Control Model and Conditional Update FT for an Experimental Model.

The tuned models showed different results, with the Control showing greater overconfidence and the Experimental Model showing greater underconfidence as compared to the Base Model. Additionally, the Experimental Model showed a more even distribution of confidence scores, which is advantageous for post-calibration.

This method for affecting confidence calibration while fine-tuning LLMs may potentially help in the broader challenge of creating reliable and trustworthy LLMs.

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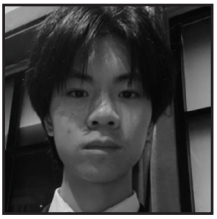
Unmasking Deepfakes: How Patch Size and Region Affect Detection Difficulty

Deepfakes are images, audio, and videos generated using artificial intelligence, often designed to closely mimic real content making it difficult to discern between authentic and fabricated materials. As these manipulations become more realistic, they raise serious concerns about privacy, misinformation, and digital trust. In most deepfake detection systems, the entire image is analyzed whereas our project investigates whether smaller patches and specific facial regions can be just as effective. We used real and fake images from FFHQ and StyleGAN2 databases: first, we trained a baseline full-image detection model, then extracted patches of various sizes to evaluate the model's ability to distinguish real from fake images. To identify the most informative facial areas, we used landmark detection to isolate regions and visualized spatial sensitivity with sliding-patch heatmaps. Preliminary results suggest certain regions and patch sizes give slightly weaker classification signals, indicating fewer distinguishing deepfake features. Future work will explore attention-based and region-aware models to improve detection efficiency, inspired by studies highlighting the role of localized patterns in deepfake detection.

Artificial Intelligence and Linguistics for Crossword Puzzles and Difficulty Analysis



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Crossword puzzles combine linguistics, semantic reasoning, pattern matching, and constraint satisfaction, making them a compelling area of study for both artificial intelligence and psychology. They require not only knowledge of vocabulary and cultural references, but also the ability to recognize patterns, interpret clues with multiple possible meanings, and fit answers into a constrained grid.

Our project is a hybrid AI crossword solver and constructor, along with research into the specific factors that make a crossword "difficult." Our project's pipeline gets a crossword puzzle from a source, normalizes the grid structure, and aligns each word slot with its corresponding clue text. A search algorithm is used to find potential solutions for a puzzle, retrieving possible candidates using regex/affix heuristics and wordlists filtered by pattern, and enforces cross-letter consistency with various search methods and constraints.

To measure difficulty, we incorporate word frequency statistics and clue difficulty. We hope that this exploration will provide insights and understand how AI systems and human solvers approach complex linguistic and logical problems, and how such AI systems might interact with humans during complex tasks.

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Reconstructing the Boundary-Layer Laminar Flow Program on ENIAC

The ENIAC Electronic Numerical Integrator and Computer was one of the first digital computers, built during WWII. The program we are working on, written by early computer pioneer Kay McNulty and mathematician Douglas Hartree, is about calculating the Laminar Boundary Layer in Compressible Flow—a challenge in ballistics and aerodynamics that examines how air moves around fast-moving objects like bullets and aircraft. Using an ENIAC simulator, we are reconstructing an early draft of their program, analyzing its structure, and identifying issues. Since this version was not final, we found several bugs and errors in the set-up diagrams. To better understand the program's design and purpose, we studied original documents, letters between Kay and Douglas, and papers Hartree wrote afterward. After making corrections, we successfully ran parts of the program. This project is an important part of computing history and computational fluid dynamics, showing how McNulty and Hartree used one of the first computers to solve real scientific challenges.

Integrating aging dynamics into a machine learning model

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The Cybernetic Learning Automaton (CLA) created by Dr. Brian L Stuart is an artificial intelligence model that was made with the purpose of emulating the learning of organisms, including humans. However, human learning is not a constant; there are many factors that have an effect on learning that need to be considered, and one major variable that has yet to be taken into account is age. This research serves to modify the existing CLA model in a way that allows it to accurately mimic human aging and the subsequent effects on learning. This allows for a more comprehensive model that is more accurate to the human brain. This was achieved through the tracking of the passage of time and the alteration of the method by which the model calculates its confidence, a factor of its responses that is used in conditioning. This led to the model becoming more confident with age, and the results demonstrated a decline in learning as the model grew "older". This is qualitatively consistent with research that has been conducted on the learning abilities of humans of different ages.

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Computational Modeling of Odor-Associated Avoidance in Fruit Flies Using Cybernetic Automata

To study memory and decision-making, it is essential to understand how animals learn from their environment. Insects such as the fruit fly (*Drosophila melanogaster*) have been widely used to explore the neural and behavioral mechanisms of classical conditioning. However, replicating these learning processes with a machine learning model-based experiment allows testing hypotheses that would be difficult to examine experimentally. This project focuses on validating a cybernetic automata model—a system that learns and adapts through feedback, mimicking natural intelligence based on cognitive science—by demonstrating that it can reproduce behavioral patterns in fruit flies. In this context, CS1 (Conditioned Stimulus 1) and CS2 (Conditioned Stimulus 2) represent attractive odors to the fly, while UCS (Unconditioned Stimulus) refers to an electric shock. The model encodes innate avoidance of the electric shock and learns to associate it with either or both odors over repeated trials, replicating experimental protocols in behavioral neuroscience. Using this simulation, I tested populations of virtual fruit flies and found that the model exhibits avoidance patterns for CS1 and CS2 odors similar to those reported in biological experiments.

Evaluating Large Language Models for SMT-Based Logical Planning with Natural Language Constraints

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Large Language Models (LLMs) are increasingly used in AI planning, either to generate executable plans or to formalize problems for solvers like Z3. While Z3 enables precise logical control, its strict syntax makes it hard for LLMs to produce correct code, especially when plans must satisfy natural language constraints. We evaluate four models (DeepSeek-R1, DeepSeek-V3, Qwen3-32B, and Qwen2.5-Coder-32B-Instruct) on a 100-example BlocksWorld dataset, both with and without constraints, across five types: numerical, sequential, state-based, goal, and initial. Without constraints, DeepSeek models improve over trials, generating more valid Z3 plans, while Qwen models fail to produce meaningful outputs. With constraints, correctness drops sharply for all models, as syntax errors and unsolvable logic become common. Numerical and sequential constraints work best, likely due to their clear, step-by-step patterns, while goal and initial constraints prove harder due to their abstract nature. Understanding these limitations is key for safely deploying LLMs in real-world systems where strict adherence to constraints is critical.

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AILA: An Intelligent Lecturing Assistant for High-Quality Formative Assessment Generation

AI-powered tools hold promises for streamlining instruction and supporting evidence-based strategies such as retrieval practice. However, prior work shows that directly applying AI often fails to distill key concepts or generate high-quality formative assessments from diverse lecture materials. This project investigates methods for producing high-quality multiple-choice questions (MCQs) to enhance student learning outcomes. We developed AILA, an Intelligent Lecturing Assistant web platform that allows instructors to upload lecture materials, from which advanced AI extracts, aggregates, and deduplicates key concepts. We first evaluated MCQs generated directly from raw lecture segments using a standardized set of 14 criteria covering educational relevance, accuracy, and quality. The analysis revealed recurring quality issues. To address them, we designed a knowledge graph (KG) based approach that extracts concepts before generating MCQs. A comparative evaluation, using the same 14 criteria, showed that KG–based MCQs were of higher quality than those generated from raw materials. These findings establish a foundation for AI-driven methods to generate scalable, high-quality formative assessments in higher education.

Modeling and Optimizing Team-Based Processes

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To improve team-based processes, one must consider activities of human workers and technologies that support individual and collaborative activities. A Drexel team is developing a Microsoft Excel-based analysis tool to support characterizing team-based processes and comparing them to those executed by other units doing similar work. My research focused on investigating whether the tool can be used for a different team process (DrexelOne advising using "Schedule Ahead"). I developed an operational event sequence diagram to document each task with descriptions, associated human roles, and systems. I created an instance of the data in the form required by the analysis tool. I used the tool to make the data consistent across tasks and to investigate ways to improve it. The tool identified inconsistencies in the naming of roles and system identifiers in the data. It failed in differentiating the human worker roles from the technological systems used to support tasks. This failure would make it difficult to identify when teams do similar work using different support systems. This gap illustrates enhancements needed to compare team-based processes and their associated technological support systems across a broader set of work domains.

Mitigating Bias in AI Dermatology Through Human–Computer Interaction

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Artificial intelligence (AI) has rapidly expanded into healthcare, including dermatology. Dermatology, unlike other medical specialties, often relies primarily on examining visible skin features such as color, texture, and lesions. Therefore, by training on large datasets of skin images, AI systems can learn to detect and classify conditions, improving accuracy and accessibility of care. However, research shows that many of these systems perform less accurately for patients with darker skin tones due to underrepresentation in training data. When the AI is trained mostly on lighter skin tones, it struggles to recognize conditions on darker skin. This bias can lead to misdiagnoses, limiting AI's potential in healthcare. While technical fixes are important, emerging studies suggest that combining AI with clinician expertise can improve the accuracy of these dermatological diagnoses. This research uses a Human–Computer Interaction (HCI) approach to explore how human– AI collaboration can be designed to mitigate bias in dermatology. Following an extensive literature review, we developed multiple scenarios illustrating this collaboration and refined one into a detailed model aimed at improving diagnostic accuracy and patient trust.

Zero-Knowledge Proof Authentication for the Web

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Password breaches remain one of the most persistent cybersecurity threats, with stolen hashes enabling offline cracking and plaintext leaks compromising millions of accounts. Traditional authentication relies on storing sensitive password data server-side, making databases a single point of failure. This research presents a zero-knowledge proof (ZKP)-based password authentication system that eliminates the need to transmit or store passwords or hashes, drastically reducing breach impact. Implemented with Circom for circuit definition, SnarkJS for client-side proof generation, and Go for server-side verification, the system allows users to prove password knowledge without revealing it. Credentials are transformed into finite field elements, combined with a cryptographic salt and nonce, and used to generate a zk-SNARK proof. The Go backend verifies proofs and manages secure sessions. A JavaScript frontend handles proof generation and communication, enabling a seamless registration/login flow. This architecture resists database breaches, phishing, and interception while preserving a familiar user experience.

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Enhancing YAMZ with UI Updates and Term Versioning for Transparency

Metadata plays a critical role in organizing and retrieving information across digital platforms, yet many metadata repositories lack mechanisms to track the evolution of term definitions over time. Without this historical context, users may misinterpret data or lose valuable provenance. The YAMZ (Yet Another Metadata Zoo) platform is an open-source metadata registry designed to make metadata terms more accessible and collaboratively curated. This project focuses on enhancing YAMZ by implementing a versioning system that records and displays the full history of changes to each term. Using Python, Flask, SQLAlchemy, and PostgreSQL, I developed a backend model to store term versions, integrated logic to automatically capture edits, and designed a user interface for viewing version history and details. Additional work included refining the site's UI for improved usability, resolving search functionality bugs, and incorporating mentor feedback on navigation and display. This enhancement supports transparency, accountability, and more accurate metadata reuse, aligning YAMZ with best practices for open metadata stewardship and facilitating better-informed decision-making for metadata professionals.

Evaluating Personal Information Leakage Through Large Language Models

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With large language models (LLMs) rapidly improving in their ability to interpret and connect information, understanding how they extract sensitive personal details from public social media posts has become urgent. Even when users reveal private information unintentionally, these models can infer attributes such as name, date of birth, age, gender, political views, location, email, occupation, and phone number by detecting subtle patterns in public content. This poses significant privacy risks, as it could be exploited for targeted attacks, harassment, or identity theft. This study evaluates the capacity of LLMs to infer sensitive personal details from user-generated posts. To enable controlled testing, we created a synthetic dataset of 100 Twitter users using OpenAI's GPT-4o, with each user having between 5 and 50 tweets to resemble realistic patterns of information sharing on Twitter. We are currently assessing the inference accuracy of models such as DeepSeek, Gemini, and LLaMA, across these attributes. Findings from this ongoing work are expected to guide the development of privacy-preserving practices and inform platform policies aimed at reducing the unintended exposure of sensitive information online.

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Effect of different chlorine treatments on the carrier dynamics in graded CdSeTe & CdTe

Cadmium Telluride (CdTe) solar cells are a cost-effective alternative to traditional silicon solar cells. Current efforts focus on increasing the efficiency of CdTe solar cells by substituting a fraction of tellurium atoms with selenium (Se) and either arsenic (As) or antimony (Sb) to change the optoelectronic properties. One critical step in improving CdTe photovoltaics is the cadmium chloride ($CdCl_2$) post-deposition. In this study, both CdTe and $CdSe_xTe_{1-x}$ absorbers doped with antimony were subjected to mild and aggressive CdCl? treatments to investigate their effects on absorber electronic structure and carrier dynamics. These antimony-doped samples were also compared to conventional absorbers doped with arsenic under identical CdCl? conditions. Photoluminescence (PL) and time-resolved PL (TRPL) measurements showed that aggressive $CdCl_2$ treatments increased selenium interdiffusion and reduced non-radiative recombination. Non-radiative recombination releases heat, which reduces power conversion efficiency. However, aggressive treatments also induced the formation of new defect states. These findings highlight the relationships between $CdCl_2$ treatment intensity, defect state formation, and efficiency in CdTe-based solar cells.

Six-Axis Robotic Automation for Optimizing Crystallization Processes

Chemical automation focuses predominantly on handling liquids, but many chemical processes involve solids, either added to solution or produced by reactions. Crystallization seeks to create high purity solids from a solution, and is critical to pharmaceutical, agrochemical, materials, and food manufacturing. In my work, a 6-axis robotic arm is used to handle solids and thus optimize crystallization processes through a python-based API. Crystallization is a nonlinear chemical unit operation as slight changes in temperature, concentration, or seeding can significantly alter experimental results. Seeding specifically is used industrially to improve purity and yield but cannot be automatically optimized using existing systems. The 6-axis robotic arm with a 600-gram payload and 0.5mm repeatability allows for an automated optimization process where testing different seeding variables is possible. Initial findings include integration of various crystallization apparatuses using python, including automated weighing of solids. Future research aims at detecting and changing temperature, seed loading, and agitation, and filtering crystal slurries all through a python API.

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The Size Dependence of Crystal Purity

Pharmaceutical manufacturing requires processes that produce high purity to ensure that medicine and drugs are safe and effective in delivering their therapeutic effects. Crystallization is a key unit operation for achieving this high purity. Impurities can take the form of unreacted starting materials, reagents added to create chemical reactions, or byproducts of intended reactions. This project will determine how the impurities distribute into product crystals based on the aspects of the crystals that determine their size. Sieving the crystals to collect multiple crystals of different sizes will allow us to determine how crystals of different sizes incorporate impurities. We use High-Performance Liquid Chromatograph (HPLC) to analyze samples of different sizes, presumed to represent crystals at different stages of process, and measure their impurity levels. We were able to find that higher sizes of crystals contain more impurities. Through these findings, we are able to fit a model that describes the impurity distribution as a function of size and to describe the size distribution as a function of process conditions.

Integrating Climate Resilience into STEM Curricula with Large Language Models

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Scaffold AI is a platform built around an extensive language model (LLM) designed to help educators integrate principles of climate resilience and sustainability into curricula. A combination of a tightly calibrated TinyLlama model and custom-made prompt engineering provides the platform with proper, context-specific recommendations related to case studies, and assignment structures based on peer-reviewed literature. A hybrid approach blends LLM reasoning and vector-based semantic searches over a curated body of studies on sustainability to ensure evidence-based accuracy and support for the answers. Real-time interactions and dynamic control over the model are supported by the web-based application while maintaining robust source attribution. The production-level first deployment is supported by robust fault tolerance and efficient conversational dynamics, including a user-friendly interface. Improved access to high-quality, research-based resources for educators enables the integration of concepts of climate resilience into STEM curricula, which enhances environmental literacy and supporting the integration of sustainability across subjects.

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Influence of Street Morphology on Urban Heat Stress: A Comparative Study of Two Philadelphia Neighborhoods

As climate change accelerates global warming, urban areas face heightened heat stress driven by features like aspect ratio and street orientation, which shape microclimate by altering solar exposure, airflow, and shading. This study examines their influence on thermal and humidity-related variables in two Philadelphia neighborhoods: Kingsessing and Haddington. The study consists of two hypotheses; (1) heat stress varies spatially within neighborhoods, and (2) heat stress depends on street aspect ratio and orientation. In each neighborhood, four streets (two high aspect ratio, two low) and 24 stops formed walking routes. Kingsessing had NE–SW and NW–SE orientations; Haddington had N–S and E–W. Heat metrics such as wet bulb globe temperature (WBGT), globe temperature, wet bulb temperature, dew point, dry bulb temperature, and relative humidity were measured with fixed QT44 sensors (continuous one-minute data) and mobile Kestrel trackers at each stop. The study will compare each of the heat metrics between the two sensors to understand the spatial variation within the neighborhood and will explore a better understanding of heat stress dynamics on to the morphology of urban streets.

Exploring the Potential of Plasma-Activated Water as a Non-Toxic Solvent

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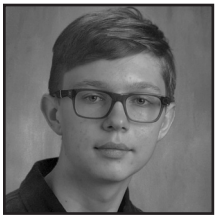
Degreasing is an essential process in industrial maintenance that is traditionally done with solvents like trichloroethene (TCE) and perchloroethylene (PCE). Although these solvents are effective, they are classified as toxic and hazardous. Previous studies used technology like plasma etching and microwave plasma interactions to successfully remove lubricant oil and clean aluminum surfaces. However, these setups required expensive and delicate machinery that could face challenges in upscaled applications.

This project focuses on exploring the potential of plasma-activated water in mist form as a viable alternative to solvents and other plasma technologies. We are utilizing the OxyFog, a plasma chamber that generates plasma-activated mist. The equipment used is cheaper and has the potential to scale up safely. In the main procedure, 7075-T6 aluminum alloy coupons applied with standard contaminants (ADS-61A-PRF) were put in contact with treated and untreated mist. Initial experiments show promise in degreasing with partial removal. Further investigation will aim to optimize the system by modifying the OxyFog and methods of monitoring system conditions.



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RFID-Enabled Smart Garments for Medical Monitoring

Smart garments, pieces of fabric that have sensors integrated into them, are an emerging technology that has the capability to revolutionize fields such as medicine. One example of this is the bellyband, a respiratory antenna sensor developed in the Drexel Wireless Systems Lab. This uses ultra-high frequency radio frequency identification (UHF RFID) to communicate with other medical devices allowing for real-time transfer of biometric data. As a wearer breathes, the bellyband compresses and relaxes, causing variations in the received signal strength indicator (RSSI) values it transmits, thereby replicating the breathing pattern. This data is monitored by a machine learning algorithm which can detect different respiratory issues and activate an associated ventilator if any trouble is detected.

Throughout the duration of STAR I worked on various aspects of the project. These ranged from running tests using the bellyband and helping develop software to interpret the gathered bellyband data to testing, adjusting and developing software for the associated ventilator system. Ultimately, the goal is to develop a way to seamlessly integrate sensors into the medical environment that allow doctors to more easily monitor patient health.

Design and Implementation of Hardware in support of 40GSPS All-Optical Analog to Digital Converter

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Analog to digital converters (ADC) are a key component for modern direct digital receivers for remote sensing, medical imaging, and communication networks. Unfortunately, a limit of 10 giga samples per second (GSPS) is reached for all electrical ADC with effective number of bits (ENOB) under 6 despite using over 4W power. Prof. Daryoush's group have devised all-optical ADC solution for realization of over 40GSPS with under 1W power consumption and 10 ENOB. My STAR efforts are in technical support of a PhD candidate and a Co-Op student. The efforts are subdivided into three tasks: realization of stable DC supply for RF limiter circuit, creation of balun circuit for interface testing of broadband spiral antenna, and design of optical comparator circuit for optical quantizer. DC to DC converters for internal power regulation were designed, simulated in OrCAD, and tested on hardware. Results show stable output voltage using TI's buck converter. Circuit boards to support balun used in spiral antenna testing were laid-out in Keysight-ADS and fabricated using a T-Tech QC 5000. AutoCAD was used to design an experimental setup of free-space optics of two spatially interleaved 4-bit Gray code optical quantizers.

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Design and Evaluation of Systolic Array Architectures for Matrix Multiplication Acceleration on FPGA

This project focuses on designing and testing a systolic array architecture for efficient 4 by 4 matrix multiplication on an FPGA, aimed at AI and neuromorphic computing applications. The design is implemented in SystemVerilog on the Zybo Z7-10 development board, using custom multiply-accumulate (MAC) units connected in a pipelined structure. A state machine manages how data is read from on-board BRAM, sent into the array, and stored after computation, making sure the operands are aligned and the data flow is synchronized across all MAC units. Input matrices are stored in memory files meant to simulate BRAM and loaded into the systolic array for fast access, and results are collected through a dedicated output interface. The design was fully synthesized, implemented, and tested on hardware using Vivado, showing efficient use of FPGA LUT and DSP resources, low power usage, and predictable computation time. This work not only gives practical experience in FPGA hardware design, but also provides a starting point for scaling systolic arrays to larger sizes for use in neural networks and other AI hardware acceleration tasks.

FPGA Implementation of Izhikevich Neuron Model in Multi-neuron Networks

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Neuromorphic computing involves developing hardware and software to simulate the neural functions of the human brain, enabling efficient and low-power computation. The Izhikevich neuron model is well-suited for this due to its efficiency and biological accuracy, mimicking various spiking behaviors using first-order differential equations. Executing this model on an FPGA enables real-time visualization of neural activity through parallelized, low-latency computation.

In this work, the Izhikevich model was implemented in Python, simulated in Verilog, and deployed on a Zybo Z7 FPGA. Fixed-point arithmetic in Q8.8 format, along with Euler's method, was used to compute the model's coupled differential equations on each clock cycle. The model reproduced distinct spiking behaviors across several neuron types (e.g., regular spiking, chattering). A multi-neuron system was then implemented, where two excitatory neurons influenced the membrane potential of a third through synapse modules. This platform is extendable to networks with *n* input neurons, feeding to *m* output neurons with parameterized synaptic weights. A prospective extension to a 784 x 256 x 10 neuron network may enable image recognition tasks such as MNIST digit classification.

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A UXID Approach to Youth Engagement in Out-Of-School Time Learning

Positive Behavior Interventions and Supports (PBIS) is a widely used K-12 framework that promotes positive behavior and reduces reliance on punitive discipline. Research shows PBIS can boost student engagement, motivation, and teacher-student relationships, leading to stronger learning outcomes. Commonly, students earn tokens or points for meeting behavior expectations, redeemable for prizes or privileges. While digital PBIS systems are increasingly used in schools, existing platforms are often too complex and time-intensive to adapt for out-of-school programs like afterschool and summer learning.

Drawing on a literature review, comparative analysis of existing platforms, and iterative design sprints implementing "Dragon Dollar" rewards for middle school youth in Drexel's Young Dragons Summer STEAM program, this project explores how PBIS principles can promote positive youth engagement beyond the classroom. Outcomes, grounded in User Experience and Interaction Design (UXID) principles, include visual concepts and key design recommendations for a digital PBIS system optimized for short-term, out-of-school learning.

Analyzing Effectiveness of LLM's Controlling CPFA for a Swarm of Robots Foraging

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The Central-Place Foraging Algorithm (CPFA) is a searching algorithm that controls individual robots within a swarm of robots. The CPFA is used in situations where there is a single collection or drop-off location (the nest) and a swarm of robots tasked with searching and collecting in an unmapped area. In this swarm, each robot has its own CPFA controller, which controls what actions the robot takes next. Although to use the CPFA algorithm, you must configure the parameters for each different environment or scenario in which the swarm of robots is put. This results in the CPFA being less flexible in uncontrolled environments. In this project, we investigated the use of LLMs for making decisions for the CPFA controllers, to allow for more variability in the scenario before a change of parameters is required. To test the effectiveness of CPFA controllers with LLMs, we created a custom simulator that allowed us to easily change parameters and the environment and test both the CPFA controller with and without an LLM making decisions. We also quantified the effectiveness of each version of the LLM to understand what worked best and what we should try adjusting next.

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Emission-Aware Adaptive Signal Control for Greener Urban Intersections

Traffic congestion at busy urban intersections remains a leading source of both delays and harmful emissions. As electric vehicle adoption grows, the dynamics between traffic flow and environmental impact are rapidly shifting, yet most signal control systems remain focused on vehicle arrivals. This project developed a SUMO-based traffic simulation to test adaptive signal control strategies that respond to either queue length or real-time CO_2 emissions getting from individual vehicles. The model simulated a four-way intersection under varied traffic demands and diverse mixes of conventional and electric vehicles. Using Python's TraCI interface, lane-level delays and emissions were collected across multiple scenarios, thresholds, and signal timing adjustments. Results revealed a strong positive correlation between queue length and CO_2 emissions, with emission-based control achieving modest reductions in emissions without increasing delays. Fine-tuned timing adjustments consistently balanced traffic efficiency with environmental performance. These findings highlight the potential for integrating emissions into control logic to create smarter, greener, and more sustainable traffic systems for modern cities worldwide.

Biocompatible, nontoxic ZnSe aqueous quantum dots for gene delivery

Aqueous quantum dots (AQDs) complexed with polyethylenimine (PEI) could deliver genes into cell nuclei through endocytosis with high efficiency, offering an alternative to traditional viral vectors. Here, we synthesized ZnSe AQDs at room temperature with 3-mercaptopropionic acid (MPA) as ligand at a molar ratio MPA:Zn:Se=8:3:1 and mixed with PEI at various PEI:AQD ratios to create biocompatible, nontoxic AQD-PEI complexes over the earlier cadmium-based system. We found the optical property and stability of ZnSe AQDs could be improved by partially replacing MPA with 3-mercaptopropyl-trimethoxysilane (MPS), aging, 6Zn1Se coating, and addition of PEI with PEI:AQD>48. In particular, PEI complex enhances edge-state photoluminescence (PL) at 360 nm to intensity >500K when excited at 330 nm. X-ray diffraction (XRD) confirmed cubic, nanosize ZnSe with broad peaks at 27.2°, 45.2°, and 53.6° indicating PEI complexing improved the crystallinity of ZnSe AQDs as consistent with a higher PL intensity. Cytotoxicity of PEI-AQD complex will be performed with HT29 cells using MTS assay and the results will be presented. Future work will involve Mn doping strategy to shift emission to near infrared range for deep imaging applications.

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Synthesis of Mo_2AlC, Mo_2SiC, and Mo_2SnC MAX Phases for Improved Etching Yield

MAX phases are layered, hexagonal structures composed of a transition metal (M), an A-group element (A), and carbon or nitrogen (X). They can be selectively etched using strong acids (HF) to produce MXenes, 2D materials notable for their applications in energy storage, catalysis, and biomedical fields. Molybdenum (Mo) MXenes exhibit mechanical strength, chemical stability, and high conductivity, making them advantageous for specific applications; however, their difficulties in synthesis have resulted in limited successful discoveries. This project aims to identify a MAX phase that can be more readily etched into MXene. In this study, three potential A elements, Aluminum (Al), Silicon (Si), and Tin (Sn), were used to synthesize Mo_2AlC, Mo_2SiC, and Mo_2SnC MAX phases, with varying stoichiometric ratios and sintering times/temperatures as the primary parameters. Subsequently, the samples were characterized using microscopy and spectroscopy techniques, such as SEM/EDS and XRD, to determine elemental distribution and formation. These results provided insight for optimizing heating times and temperatures to develop pure Mo-MAX phases with different A elements, thereby enhancing the yield and functional properties of the resulting MXenes.

Solid Polymer Electrolytes

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Increasing demand for safer, longer-lasting, and higher-capacity energy storage, driven by electric vehicles and other innovations, has made addressing the limitations of conventional lithium-ion batteries critical. Conventional lithium-ion batteries, while widely used, rely on flammable liquid electrolytes that can leak, form lithium dendrites, and degrade under extensive use, posing safety and stability concerns. Solid polymer electrolytes (SPEs) offer a safer, more stable alternative with potential to suppress dendrite growth and extend battery life. Poly(methyl vinyl ether-alt-maleic anhydride) (PAH) and Jeffamine (polyetheramines) are promising SPE components because they form crosslinked networks that combine strength and flexibility. SPEs were prepared from PAH and two Jeffamine polymers, varying the amine ratios, lithium salt concentrations, and solvent blends. Selected formulations also include ultra-high molecular weight polyethylene oxide (PEO) to enhance mechanical strength. Mechanical strength and film uniformity were assessed. Other important properties of SPEs, such as ionic conductivity and electrochemical stability, while critical for battery applications, were considered beyond the scope of this work.

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Development and Effect of Partial Oxidation of V_2CT_x and $V_4C_3T_x$ MXenes for Cathode Applications in Aqueous Zn-ion Batteries

Aqueous zinc-ion batteries (AZIBs) are considered a promising alternative to widely used Li-ion batteries due to being safer, more cost-effective, and environmentally friendly. MXene-derived Zn-preintercalated bilayered vanadium oxide (MD-ZVO) has shown potential as a cathode active material (CAM) for AZIBs, offering high energy density but limited by low rate performance. At the same time, the MXene precursors have excellent electrical conductivity. This research investigated the feasibility of using partial MXene oxidation during synthesis to produce CAMs with conductive MXene chemically integrated into the oxide crystal structure, potentially improving rate performance. Experimental variables included lowering or diluting the amount of oxidizing agent (H_2O_2) and reducing the settle time following the reaction with H_2O_2. V_2CT_x and $V_4C_3T_x$ MXenes were used as precursors due to their ability to form distinct nanoflower morphologies. Based on XRD and SEM analyses, partial oxidation can be achieved, with XRD patterns corresponding to two-phase MXene/oxide samples and distinctive morphologies. This poster will demonstrate the effect of partial oxidation on charge storage properties of V_2CT_x - and $V_4C_3T_x$ -derived materials in AZIBs.

Natural Polymer Nanoyarns for High-Performance Applications

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Many billion-dollar industries, including healthcare, clean energy, and manufacturing, lack materials that are both high-performance and adaptable. Nanoyarns, composed of continuous nanofibers twisted into a yarn, offer a versatile solution with unique properties for applications ranging from tissue engineering to advanced filtration systems. This project focuses on optimizing production of nanoyarns made from natural polymers for improved yield and quality using a custom-built nanoyarn machine developed exclusively in the Natural Materials Polymer Processing Lab. This machine takes solutions that are first electrospun into nanofibers, that are then drawn down and twisted into a yarn. Several polymer systems were created for experimentation using Polyethylene Oxide and various natural polymers including Carboxymethyl Cellulose, Keratin, Cellulose Acetate, Pectin, and Chitosan, each with their own solvent system. Results show proof-of-concept for improved natural polymer-based systems and lay the groundwork for fine-tuning solution parameters, environmental controls, and machine settings to achieve consistent, sustainable nanoyarn production for advanced eco-friendly material applications.

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Electrospun Polyacrylonitrile and Biochar Nanofibers for Filtration Applications

Developing sustainable filtration materials is essential for mitigating air pollution and greenhouse gas emissions. One mitigation approach is through advanced filtration materials that can be produced with electrospinning. Electrospinning is a technique where nanofibers are drawn from a polymer solution by an electric field, enabling the production of high surface area filtration materials. Polyacrylonitrile, PAN, offers strength and stability, forming durable nanofiber mats. Biochar produced by the pyrolysis of organic waste is cost-effective and highly porous, capable of adsorbing CO_2. Biochar cannot be electrospun alone but combining it with PAN allows for the fabrication of fibers with enhanced adsorption potential. This study incorporates 1-15 wt% pine biochar into a 10% PAN/N, N-Dimethylformamide solution, tackling humidity, conductivity differences, viscosity changes, and PAN-biochar separation to optimize fiber formation. The results provide strategies for producing cohesive, biochar-infused nanofiber mats for air filtration. Future work aims to explore a variety of biochar and natural polymers to find the most efficient biochar-polymer combination and ratio that maximizes the amount of biochar for optimal air filtration.

A Low-Cost Wearable Device for EDA and HRV

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Low-cost wearable systems for measuring electrodermal activity (EDA) and heart rate variability (HRV) provide valuable opportunities to study psychophysiological reactions in real-world environments. However, capturing clean and reliable signals in a natural environment still remains a challenge. This project develops an affordable, Arduino-based wearable system to collect physiological data in classrooms, study groups, and other team-based settings. The design integrates commercially available EDA and HRV sensors, providing secure and comfortable placement, along with basic onboard filtering to minimize noise and motion artifacts. The prototypes were tested, and data was collected and processed in MATLAB/Python. The initial tests evaluated the performance during a simulated team task, providing preliminary insights into its reliability in active, everyday situations. By lowering cost and technical barriers to high-quality monitoring, the system broadens access to tools for exploring psychophysiological reactions in collaborative problem-solving. All designs, code, and documentation are openly shared to support future replication and improvement

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Detecting the Physiological Signatures of Cognitive Insight

Learning often results in a sudden 'Aha!' moment in which the learner experiences a radical change in knowledge structure. Although the 'Aha!' moment is perceived by the learner as purely cognitive, the cognitive activity creates distinct and observable reverberations in the body's autonomic nervous system (ANS). To observe the connection between cognition and physiology, we developed a low-cost, open-source system composed of an Arduino equipped with galvanic skin response (GSR) and photoplethysmography (PPG) sensors. The sensors transmit data to a Python application that displays the incoming signals in real-time while also logging all data to simple timestamped comma-separated value (CSV) files. During the live session, the application processes the PPG stream to calculate beat-to-beat heart rate variability (HRV) metrics such as beats per minute (BPM) and root mean square of successive differences (RMSSD). For more advanced electrodermal activity (EDA) analysis, the GSR data file is imported into MATLAB after the session, where a Butterworth filter is applied to isolate the phasic Skin Conductance Response (SCR). Our 'Aha!' moment platform provides an effective way to view and study the physical signature of an epiphany.

Table Occupancy Detection Using Jetson Nano and YOLOv8

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This project presents a low cost system that reports public space (such as dining halls or study areas) availability in real time without cloud. A Jetson Nano with a Raspberry Pi camera captures images locally and sends the image to YOLOv8 to detect tables and people. A Python script assigns occupancy by measuring overlap (IoU) and proximity between person and table bounding boxes, and a webpage renders an user provided blueprint and color-codes each table, refreshing automatically every minute. For optimization, the YOLOv8 model was filtered to have fewer classes, tuning image size and thresholds, and minimizing memory traffic. The prototype updates reliably from snapshots with low latency on the Nano. Planned extensions include continuous video capture, homography for stable table IDs on the floor plan, multi-camera coverage, and simple analytics such as dwell time and peak hours. Running the full pipeline on the Jetson Nano provides a practical, portable approach to real time space utilization in public spaces on campus. This provides students with up to date seating information and can help staff manage flow and cleaning schedules.

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"Pinning Porosity" – Dry Electrode Fabrication & Processing

Creating efficient batteries through eco-friendly processes is key to global sustainability. Most lithium-ion batteries use wet processes, involving liquid binders like NMP or PVDF that evaporate from the slurry to form electrode films. This step releases harmful chemicals, adds carbon emissions, and demands energy for drying. Dry processes eliminate evaporation, making manufacturing more sustainable, energy-efficient, and cost-effective. Studies also show that dry electrodes often outperform in capacity and cycle life span. Though still emerging in industry, its advantages highlight the need for research, development, and optimization. My work focused on trying to control electrode porosity during fabrication. Porosity strongly influences electrolyte transport and reaction surface area, making it an important factor to be able to control and replicate for production. While higher porosity can improve performance, too much reduces conductivity and weakens mechanical strength. I examined how porosity changes with thickness, compression, kneading, and mixing. Results suggest porosity is set when the film forms and depends more on material choice than any post-processing.

Exploring Hard CarbonSilicon and Binder–Solvent Compatibility to Optimise Current Collector Adhesion and Capacity in Sodium–Ion Batteries

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Sodium-ion batteries (SIB), while a cost-effective and sustainable alternative to lithium-ion batteries, are known to have a lower energy density and capacity retention. This study explores composite hard carbon silicon SIB anodes for increased capacity as well as binders and processing variables for dry SIB electrodes. Ratios of hard carbon to silicon were varied to gauge the effect on capacity and cycling stability. We further investigated dry film electrode processing by using carboxymethyl cellulose (CMC) solutions of various weight percentages to adhere the electrodes made with PTFE to the current collector, as well as calendaring them to the foil to improve contact. Binders such as CMC and polyvinylidene fluoride (PVDF) were compared for electrode-current collector adhesion to explore solvent compatibility and eliminate the use of N-methylpyrrolidone (NMP). The results were quantified using Galvanostatic charge-discharge testing to analyse charge/discharge cycles, scanning electron microscopy to visualize microstructure of materials, and X-Ray diffraction to analyze phase transitions. We can conclude that all composite anodes did not cycle completely and showed high internal resistance and delamination within the cell.

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Systematic assembly of reactive metal interphases

The performance and longevity of lithium-ion batteries (LIBs) are affected by the formation of a mechanically robust solid electrolyte interface (SEI). The SEI is a 10-20nm thick passivation layer that forms during the first charge and discharge cycle due to electrolyte reduction. Its function is to prevent further electrolyte decomposition, preserving battery capacity and performance over time. Due to this, the selection of electrolyte solvents, salts, and additives has become a key area of research to further stabilize the SEI. Despite its importance, the specific contribution of individual solvents and additives to the SEI's mechanical performance remains poorly understood. This research aims to systematically analyze the impact of different solvents and additives on the SEIs mechanical properties by utilizing ultrasound and three-point bend testing. Specifically, it will examine varying concentrations of fluoroethylene carbonate (FEC) and vinylene carbonate (VC) as additives in ethylene carbonate and dimethyl carbonate to determine the ideal additive percentage to improve the overall mechanical robustness of the formed SEI.

Design Optimization and Simulation of Pneumatic Universal Silicone Grippers

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Soft robotics grippers are a different approach to solving problems compared to standard hard grippers which allow for delicate handling, higher degrees of freedom, and more adaptability. This project specifically focuses on pneumatic universal silicone grippers, capable of handling variety of objects with different shapes and sizes. Each mold for the silicone grippers is created using 3D printed models designed on AutoCAD Inventor. Molds are derived from a rectangular base design with 5 cylindrical air chambers. The parameters are then modified or different geometric structures are used to evaluate the effects on their bending angle and checked for potential mold failure or structural design failure. Also, before many of the mold designs were printed, Finite element analysis was conducted on Ansys to predict deformation, elastic strain, and overall stress. The prototypes were tested using syringes to pneumatically actuate the gripper and achieve a gripping motion. A rough visual comparison would be done between the different responses between the modified gripper and its original design. The experimental setup itself was also improved upon to increase efficiency as a push pin was designed eliminating the need for screws.

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Parametric Study of Salt Removal Rates in Novel Screw Flow Cell for Flow Electrode Capacitive Deionization

Flow electrode capacitive deionization (FCDI) provides a low-energy solution to the growing issue of freshwater scarcity. In this project, the FCDI process was performed using an innovative flow cell design referred to as the Nested Archimedes Screw - Electrochemical Flow Capacitor (NAS-EFC), which improves ion adsorption through high rates of particle-electrode interactions. The cell features concentric, counter-rotating screws driven by an external motor and separated by an ion-exchange membrane-lined brackish water channel . The study assessed how initial feedwater concentration, motor speed, and applied voltage affected average salt removal rate (ASRR) and specific energy consumption (SEC), among other metrics. Experiments involved running the saline feedwater at a constant flow rate through the NAS-EFC and measuring effluent ionic conductivity and current response under constant voltage. Preliminary findings indicate that a higher applied voltage maximizes both salt removal and energy consumption. The average ASRR and SEC were about 2.43 µmol cm-2 min -1 and 1.17 kWh kg, respectively. This project aids progress towards the scaling of optimized FCDI systems that can be used globally for providing potable freshwater.

Knitted Fabrics as Everyday Metamaterials: Mechanical Performance Across Patterns, Directions, and Materials

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Knitted fabrics are an everyday metamaterial increasingly used in adaptive clothing, biomedical textiles, and soft robotics thanks to their unique flexibility, adaptability, and comfort. Yet, the mechanical performance of different patterns in varying directions and materials remains underexplored. This study examines the tensile behavior of stockinette, garter, and rib patterns produced in soft-robot-like 3D-printed TPU and yarn, aiming to identify optimal configurations for engineering applications. Mechanical properties like stress, strain, and Young's modulus were evaluated through tests in horizontal and vertical orientations, complemented by 3D software analysis of individual loops to explore microscale behavior rarely addressed in literature. Results reveal that overall, rib patterns exhibit the highest flexibility, stockinette withstands greater stress, and garter provides balanced properties, with trends consistent across both materials. These findings address a key gap in textile mechanics, enabling the design of fabrics with modified structure and direction for comfort, durability, and performance in a future where smart wearables, regenerative skin textiles, and advanced soft robots all begin with a single stitch.

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Constitutively Modeling Deformation in Knitted Loop Geometry Using Cubic Bézier Curves

Knitted fabrics have a variety of applications across various fields, including but not limited to clothing, soft robotics, and wearable technology. Given their extensive use in multiple industries, it is essential to be able to predict their mechanical response to different kinds of loading. The purpose of this project is to constitutively model the deformation of knitted loop geometry under vertical tension while maintaining functional realism. Due to the complex geometry of a knitted structure, a fully analytical approach is not feasible. A cubic Bézier curve function was employed to model the structure of a jersey knit. A deformation parameter was included in the function definition after visual verification of the model geometry in its undeformed state. The undeformed model was imported into a finite element method (FEM) software to simulate vertical tension. The root-mean-square error between the two deformed models obtained from the Bézier function definition and the simulation software was calculated to be 0.2043 mm. It should be noted that this model is in the early stages of development and can further be expanded to include different kinds of knit structures as well as different kinds of loading (e.g. compression).

Validating oncogenic GNAS–associated transcriptional changes in human pancreatic ductal organoids

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Pancreatic ductal adenocarcinoma (PDAC) can arise from intraductal papillary mucinous neoplasms (IPMNs), in which GNAS-activating mutations are common. Our lab previously found that oncogenic GNAS alters MAPK–RSK1 signaling in pancreatic ductal organoids, potentially through changes in transcriptional programming. In this STAR Scholar project, using prior RNA-seq data, we used qPCR to validate transcriptional changes of RSK1–dependent effectors in mutant GNAS-expressing pancreatic ductal organoids. RNA was extracted from control and mutant GNAS-expressing pancreatic ductal organoids, reverse transcribed to cDNA, and analyzed for gene expression changes in two RSK1-effectors, ARHGAP24 and DLC1. Our qPCR analysis validated upregulation of ARHGAP-2 (~11-fold) in GNAS-mutant organoids, while RSK1 and DLC1 mRNA levels remained unchanged. These results link phenotypic changes in proliferation to transcriptional reprogramming under oncogenic GNAS activation. Current efforts are focused on repeating our qPCR results for reproducibility and to then assess whether inhibition of validated RSK1 effectors can reverse mutant GNAS-mediated proliferative effects in pancreatic ductal organoids.

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Investigating the Transformation Capacity of Oncogenic PIK3CA in Pancreatic Ductal Cells

Pancreatic Ductal Adenocarcinoma (PDAC) is the deadliest form of pancreatic cancer that results from two main types of precancerous lesions, namely Intraductal Papillary Mucinous Neoplasms (IPMNs) and Pancreatic Intraepithelial Neoplasias (PanINs). Although genomic studies indicate that oncogenic mutations in $GNAS^{R201C}$ and $PIK3CA^{H1047R}$ are observed primarily in IPMN lesions, exactly how they participate in IPMN progression is unclear. Previous data from our lab showed that oncogenic GNAS alone is not sufficient to transform pancreatic ductal cells. During this project, we explored the ability of oncogenic PIK3CA alone or in combination with GNAS to transform pancreatic ductal cells. Using western blot analysis, we first validated the expression of our transgenes. After multiple optimizations, using soft agar assays, our preliminary results indicate that while normal pancreatic ductal cells are unable to grow in soft agar, expression of oncogenic $PIK3CA^{H1047R}$ alone is sufficient to support anchorage independent growth after 10-20 days. Current efforts are focused on assessing whether combinatorial mutations in both PIK3CA and GNAS can enhance our anchorage independent growth phenotypes.

Probing VanS Structure to Understand Its Mechanism of Vancomycin Recognition

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Antibiotic resistance poses a growing threat to public health, as treatment options for serious infections become increasingly limited. This project focuses on vancomycin-resistant enterococci (VRE), a group of bacteria that survive exposure to vancomycin by activating resistance pathways. VRE use the VanRS two-component system to sense vancomycin and initiate this response. VanS, the sensor histidine kinase in this system, contains a periplasmic domain called periB that binds vancomycin directly, though the mechanism of this interaction remains unclear. To better characterize how VanS detects vancomycin, I designed two truncated constructs: Native-Δ C, in which a potentially disordered C-terminal region is deleted but otherwise resembles the wild-type domain, and Ncap-Δ C, which includes an additional N-terminal truncation. I generated both constructs via site-directed mutagenesis, expressed them in *E. coli*, and purified the proteins using affinity and size-exclusion chromatography. I then compared their vancomycin binding and crystallization behavior to each other and to the wild-type VanSB periplasmic domain. This work aims to clarify the molecular basis of VanS sensing and support future efforts to disrupt resistance in VRE.

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Testing second generation ACSS2 inhibitor in Breast Cancer Brain Metastatic Cells

Breast cancer brain metastasis (BCBM) occurs when breast cancer spreads to the brain and forms a generally untreatable tumor. There are currently no truly effective drug treatments being used for patients with BCBM leading to the fatality of this disease. The destructive growth of BCBM relies on the tumors using the enzyme acetyl-CoA synthetase 2 (ACSS2) to convert acetate into acetyl-CoA, as a source of energy. This metabolic pathway for tumors is used since there is intense competition for glucose in the brain. The Reginato lab has previously proven that targeting ACSS2 with an inhibitor to this pathway can reduce tumor growth and kill breast cancer cells. In this project, we have tested novel second generation ACSS2 inhibitors that are expected to work at lower concentrations. Here, we show that using the second-generation inhibitor 8007-110B can reduce breast cancer brain tumor growth in crystal violet assays compared to first generation inhibitors 8007 and 5584. We have also treated ex vivo brain tumor slices from mice with this drug and have shown promising reduction in the size of the original brain tumors from mice with BCBM. Thus, second generation ACSS2 inhibitors may hold promise in treating patients with breast cancer brain metastasis.

Targeting p90-RSK1 in Breast Cancer Brain Metastatic Cells

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Triple-negative breast-cancer accounts for 10-15% of breast cancers and is the subtype that has the highest occurrence of brain metastasis (BCBM). Within one year of brain metastasis diagnosis, 80% of patients will not survive. We have previously shown that BCBM cells contain high levels of a post-translational modification known as O-GlcNAc. Both O-GlcNAc and the enzyme responsible for this modification, OGT, are highly elevated in BCBM cells compared to parental breast cancer cells. A proteomic analysis identified p90-RSK1 as being O-GlcNAc enriched in BCBM cells. Crystal violet staining demonstrated that treating BCBM cells with p90-RSK inhibitor (RSKi) decreased cell viability. Additionally, EdU staining showed decreased proliferation in BCBM cells treated with RSKi. *Ex vivo* data displayed slower tumor growth after increasing the amount of RSKi added over 10 days. Moreover, phosphoproteomic analysis identified decreased phosphorylation of SLC38A1 in cells treated with RSKi. Western blotting confirmed that increasing the concentration of RSKi correlated with a decrease in SLC38A1. Overall, this study highlights p90-RSK1 as a novel O-GlcNAc regulated protein and a potential therapeutic target for targeting BCBM.

Enzymatic Production and LCMS Analysis of Early Cobamide Pathway Intermediates

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Vitamin B12 is a cobamide that is required for human health through the process of methionine metabolism. Cobamides are cobalt-containing cofactors essential to life that are only biosynthesized by prokaryotes. Biosynthesis of cobamides is a complex process that can be broken down into three parts. Some bacteria only encode one or two parts, and thus need to salvage intermediates from their environment. To produce these intermediates in the lab, we expressed and purified Escherichia coli HemB, HemC, HemD, and CysGa. Using these enzymes, we produced in vitro several of these early intermediates (porphobilinogen, uroporphyrinogen III, sirohydrochlorin). We varied reaction conditions (time of incubation, temperature, pH, reductant, substrates, cofactors) to optimize yield. Intermediates were observed via liquid chromatography mass spectrometry (LCMS). Concentration of 5-aminolevulinic acid (starting material) was found to have liminal effects on porphobilinogen production, whereas longer incubation times lead to higher yields of sirohydrochlorin. In this project, I successfully performed LCMS on these enzymatic reactions, with the goal of optimizing yields of intermediates to be used in future studies.

Difference in PACAP function after the development of ethanol dependence

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The "dark side of addiction" hypothesizes that drug use starts for rewarding effects, but as dependence develops, drug use is to avoid the negative effects of withdrawal. The paraventricular thalamus (PVT) manages the stress response, sends projections to the nucleus accumbens (NAc), and expresses the neuropeptide, pituitary adenylate cyclase-activating polypeptide (PACAP). To determine if $PACAP^{+}$ cells in the PVT → NAc pathway participate in ethanol intake and dependence, we excited this pathway in ethanol drinking mice. We injected PACAP-Cre mice (N = 27) in the PVT with Cre-dependent excitatory or control DREADDs and implanted cannulas in the NAc. We then gave them 20% ethanol on an intermittent access (IA) procedure for 4 weeks, and induced dependence or maintained non-dependence with exposure for 4 weeks to chronic intermittent ethanol (CIE) vapor or air. After a return to IA, we injected in the NAc within-subject with CNO or vehicle. Our preliminary results show that while $PACAP^{+}$ cell activation in non-dependent mice decreased ethanol intake, activation in dependent mice increased it. This suggests that PACAP could be a therapeutic target for alcohol use disorder, but its use should differ based on physiological state.

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Modeling Tau-Driven Neuroinflammation and Vascular Damage in Alzheimer's Disease Using Immune-Competent, Vascularized Stem Cell-based Organoids

Alzheimer's disease (AD) is a progressive neurodegenerative disorder that steals memory, cognition, and ultimately life. It is marked by amyloid-β plaques and tau pathology, though tau pathology is most strongly linked to cognitive decline. In AD, tau proteins become phosphorylated, truncated, and misfold, forming aggregates that spread between neurons and deposit in blood vessels and microglia. This fuels neuroinflammation, disrupts cerebral vasculature, and breaks down the blood–brain barrier—accelerating brain atrophy. Yet no human model fully captures tau's interplay with immune and vascular systems. Our project builds immune-competent, vascularized cortical organoids from patient-derived stem cells to model tau propagation in the forebrain and locus coeruleus. By incorporating microglia (the primary immune cells of the CNS) and a vascular network, we recreate AD's key immune and vascular features. Oligomeric tau fibrils from AD patients will be seeded into these organoids and analyzed with hyperphosphorylation-tau (AT8) and conformation-specific (TOC1, TNT2 and MC1) antibodies to reveal how tau species drive neurodegeneration, neuroinflammation, and vascular damage, advancing understanding to guide new therapies.

Investigating Motor Neuron Degeneration between Cortical and Spinal Organoids and Assembloids

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Amyotrophic lateral sclerosis (ALS) is a progressive fatal neurodegenerative disease characterized by the loss of upper motor neurons (UMNs) in the cortex and lower motor neurons (LMNs) in the spinal cord. Two main pathological hallmarks of ALS are mutations in C9orf72, causing a hexanucleotide (GGGGCC) repeat, and TDP-43, causing a gain-of- or loss-of-function. In ALS post-mortem tissue, these mutations were shown to disrupt the corticospinal tract between UMNs and LMNs but currently there is no answer to which region undergoes degeneration first. To determine the mechanistic differences between cortical UMN and spinal LMN degeneration, we will develop spinal and cortical organoids - 3D spherical structure mimicking the human microenvironment - from human induced pluripotent stem cells (hiPSCs) derived from an ALS patient and its isogenic control. These organoids will undergo fusion (termed "assembloids") to examine the disruption along the corticospinal and the mechanistic aspect of motor neuron dysregulation. We will analyze our model using immunohistochemistry (IHC) and qRT-PCR at 1- and 3-months. This study will provide a mechanistic insight to the neurodegenerative effect on motor neurons in ALS.

Effects of EcoHIV Infection and Cocaine Exposure on Stress Behavior and Astrocytic Glucocorticoid Receptor Activation

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People with HIV (PWH) have high rates of substance use disorders. HIV infection and drug use are associated with glucocorticoid system dysregulation, which may impair stress responsivity. PWH exhibit elevated basal levels of the glucocorticoid cortisol, but a reduced cortisol response during stress, while drug use is linked to both high basal and stress-induced cortisol. Cortisol binds to glucocorticoid receptors (GR) which regulate gene expression and cellular function. Astrocytic GRs are particularly sensitive to stress.

Phosphorylation of GR at Ser 211 is associated with increased transcription, an indicator of GR activation. This project investigates the effect of the chimeric HIV virus, EcoHIV, and cocaine exposure on stress response and astrocytic GR activation in the nucleus accumbens, a brain region central to reward and motivation. EcoHIV-infected female, but not male, mice with a history of cocaine exposure exhibited an increase in immobility in the forced swim test, a measure of stress-related behavior. Further, we will investigate the relationship of astrocytic phospho-GR expression and forced swim stress behavior. These findings could help identify new ways to improve stress regulation in PWH.

The Pharmacology of Allosteric Modulator Analogs of the Dopamine Transporter – Therapeutic Leads for Treating Cocaine Addiction

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Pharmacology and Physiology

Psychostimulant drug addiction is a well-known yet out-of-control issue in the United States. Monoamine transporters are the target for these psychostimulants, including cocaine, which block dopamine (DAT), serotonin (SERT), and norepinephrine (NET) transporters. Our lab has previously discovered the compound KM822 that interacts with DAT through allosteric binding and can influence the function of the transporter and block the behavioral effects of cocaine. This has led us in this project to test thirteen new compounds that are analogs of KM8222 as DAT and NET inhibitors. To test their properties, I will introduce DAT and NET cDNA into COS-7 cells. With the cells, a radioactive dopamine uptake assay will be performed to test if the compounds will interact with DAT and NET. In this dose-response assay, I will observe the difference in concentration of compounds needed for interacting with the DAT and NET. Through this research, new drugs can be further studied to find solutions to psychostimulant use disorders and be further branched to better understand other neurological disorders involving dopamine, such as ADHD and schizophrenia.

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Legliz, Lekòl, Lakay: Assessing the Validity of Biological Age Models in Haitian Immigrants

Biological aging is shaped by genetic, environmental, and social factors; however, most aging models are based on homogenous, predominantly white populations, limiting their accuracy and relevance in diverse communities. Roughly 30,000 Haitian immigrants live in Philadelphia, comprising approximately 2% of the city's population. As a growing and underrepresented group in aging research, they face unique stressors, including immigration, discrimination, and socioeconomic inequality, that may accelerate biological aging. This study investigates whether commonly used biomarker-based aging models accurately reflect aging in Haitian immigrant adults ages 18–100. We examine correlations between biological age estimates and functional outcomes, including grip strength, walking, and cognitive performance, all predictors of morbidity, mortality, and independence in older adults. Comparisons are drawn to NIH normative values and a predominantly white data sample. Guided by the Haitian principle, "*Legliz, Lekòl, Lakay*" (Church, School, Home), recruitment focused on building trust in community spaces. Despite barriers like language and fear, two individuals have enrolled, marking the beginning of an effort to advance inclusive aging research.

Mind Over Age: How Sex and Exercise Shape Cognitive Aging

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Dr. Meghan Smith
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Age is the primary risk factor for cognitive decline, and physical activity is known to protect brain health. Recent evidence suggests that biological sex affects adaptation to exercise later in life, particularly after menopause in women. Despite comprising two-thirds of Alzheimer's Disease cases, female aging is underrepresented in literature. This study examined sex differences in cognitive outcomes across young sedentary (YS; 27±6 yrs), older sedentary (OS; 70±7 yrs), and older physically active (OA; 68±5 yrs) adults. Participants completed NIH-Toolbox assessments of several domains of cognitive function including episodic memory, attention, working memory, processing speed, and verbal learning. No major sex differences emerged, except for YS females outperforming YS males in the episodic memory test (F: 125 ± 10; M: 106 ± 8; $p = 0.006$) and OA females outperforming OA males in the verbal learning test (F: 27 ± 3; M: 23 ± 3; $p = 0.028$). These findings align with broader evidence that women often show stronger cognitive performance in late adulthood but may decline more rapidly once deterioration begins. This study emphasizes the need to consider sex as a biological variable and menopause as a key factor in cognitive aging.

Audrey Ling

Antoinette Westphal College of Media Arts & Design
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Assessing the Social Impact and Community Perception of Philadelphia's Green Stormwater Infrastructure

In Philadelphia's combined sewer system, heavy rains can cause sewage overflows, polluting local waterways. Since 2011, the City has constructed green stormwater infrastructure (GSI) to reduce such overflows. While the economic and environmental impacts of GSI are known, the social benefits are understudied. Our study aims to document social activity at GSI sites. While GSI types vary, this study focused on the city-owned rain gardens. Geodata was obtained from OpenDataPhilly. Of the 198 sites in the database, 170 met the inclusion criteria of completion and public accessibility. Each site was observed for 15 minutes on a single day. We captured the site's physical features, visitor activity via a standardized checklist, and took photos to document vegetation and drainage infrastructure. By conducting interviews at a representative site, we explored visitors' GSI knowledge and perception of social benefits. Preliminary analysis shows that 95% of sites had at least one visitor at the time of our visit. Visitors' most common activities varied based on their race, gender, and age. Showing how site characteristics influence social engagement will allow for future GSI design to address environmental, economic, and social benefits.

Socioeconomic Status, Workplace Physical Hazards, and Epigenetic Aging: A Cross-Sectional Analysis Using Data from the Midlife in the United States (MIDUS) Study

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This study investigates the relationships among socioeconomic status (SES), workplace physical hazards, and epigenetic aging – a cellular indicator of physiological wear and tear predictive of age-related morbidity and premature mortality. Data were from 900 participants in the MIDUS study wave 2 and Refresher who completed the biomarker protocol and had linked O*NET occupational data. SES was based on the highest educational attainment (lower vs bachelor's degree or higher), while workplace physical hazards was based on ten O*NET indicators that quantify workplace hazards and dangerous environmental conditions. The main outcomes include five epigenetic age acceleration (EAA) measures (Hannum, Horvath, Horvath 2, PhenoAge, and GrimAge) and one measure of pace of aging (DunedinPACE). Hypotheses were tested using a series of multiple linear regressions, adjusted for sociodemographic and health-related covariates. Participants with lower levels of education showed significantly higher workplace physical hazards. Lower education was also associated with faster epigenetic aging (i.e., EAA GrimAge and DunedinPACE). However, workplace physical hazards were not significantly associated with epigenetic aging outcomes.

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Ultra-Mobile SSVEP BCI for Real-World Neuroergonomics

Brain–computer interfaces (BCIs) that rely on high-density Electroencephalography (EEG) based brain monitoring perform well in laboratories but are too cumbersome for everyday use. We present an end-to-end neuroergonomic BCI built around an ultra-mobile battery-operated BioRadio EEG device and an application-centric streaming framework that supports diverse tasks with few-channel configurations. To demonstrate feasibility, we developed BCIMan, a Pac-Man variant video game controlled via steady-state visual evoked potentials (SSVEPs). The system affords plug-and-play operation without user training and remains robust under ambient noise. An online pipeline performs frequency-domain detection with topographic validation; complementary offline analyses confirm reliable target discrimination in mobile conditions. In preliminary tests, the system enabled dependable game control with minimal setup and channels, establishing the practicality of ultra-portable SSVEP BCIs for real-world deployment. The framework generalizes beyond gaming to hands-free interaction in everyday settings and can be extended to multimodal inputs (e.g., eye tracking) to expand command sets and resilience, with potential to enhance autonomy for individuals with motor impairments.

From Text to Insight: Leveraging LLMs to Structure Physician Narratives by Assessing Traumatic Brain Injury Severity from CT Scans

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Physician-authored cranial computed tomography (CT) reports are crucial for assessing traumatic brain injury (TBI), but their unstructured, unorganized format presents a significant challenge. Critical findings are embedded within dense clinical texts, hindering rapid clinical decision-making. This project leverages Google DeepMind's MedGemma, a medical language-based large-language model (LLM), to transform unstructured physician narratives into an organized format. The LLM processes de-identified TBI-related CT narratives to systematically extract and quantify key radiographic features, presenting them in a structured format with cranial maps and detailed reasoning. The primary goal is to streamline clinical workflows by providing a clear, organized synthesis of TBI CT scan evaluations for easier, at-a-glance interpretation. While LLM text analysis may introduce occasional minor errors, the structured output is a significant improvement in clinical readability and consistency over original free-text narratives. This work evaluates a novel computational method to make critical information from TBI CT scan reports more accessible and objective, enhancing the utility of physician reports and the efficiency of patient TBI care.

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Christian D'Andrea (STAR 2016)
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Comprehensive quantification of 3D vertebral morphology and growth patterns in skeletally immature normative and scoliotic piglets

Scoliosis, characterized as the abnormal lateral curvature of the spine, can lead to debilitating pain and respiratory issues. Posterior spinal fusion used to surgically treat spine deformity is growth restrictive. Hence, newer treatments seek to preserve motion and growth while correcting curvature. Development and testing of novel surgical techniques require preclinical porcine models. However, the vertebral growth patterns in normative and scoliotic pigs are not well understood. Therefore, this study aims to quantify and compare age-dependent changes in vertebral morphology in skeletally immature normative and scoliotic Yucatán piglets. Using 3D Slicer, 3D vertebral reconstructions were created using chest and abdominal CT scans of normative and scoliotic Yucatán piglets. The 3D vertebral surface geometries were then analyzed using custom MATLAB code that measured vertebral heights and wedging angles. By quantifying how these measurements change as a function of age and spine deformity progression, the differences between pig and human vertebral growth patterns can be better understood and used to inform the future development of growth-sparing treatments for scoliosis.

Creating Deep Learning Models to Automate Landmark Point Identification in Adolescent Idiopathic Scoliosis Patients

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Approximately 1-3% of 10-16-year-olds have Adolescent Idiopathic Scoliosis, a spine deformity characterized by lateral curvature combined with axial rotation. Severe cases may require surgical correction. To optimize for this correction, some surgeries require the use of patient-specific "digital twins" to simulate surgical plans. To create these, geometric information from the patient's X-ray imaging is needed. The current study aims to create deep learning models to automate identification of vertebral landmarks from patient X-ray images. To inform the deep learning model, training data must be manually collected. A custom software was used to identify specific vertebral landmark points, (ex. vertebral vertices) and compiled to create a training dataset. Furthermore, a reliability analysis of the manual annotation process was performed across three independent observers. Such deep learning models will help automate key clinical measurements such as Cobb angles, which can further help with our understanding of scoliosis and other spinal disorders, as well as help guide clinicians in developing treatment plans.

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Maintaining Long-Term Growth in CAR T Cells

Chimeric antigen receptor (CAR) T cells are immune cells that are engineered to activate upon exposure to chosen molecules, allowing them to target difficult diseases such as liquid cancers. However, the process of manufacturing these therapies does not always work if the patient's cells were too severely weakened by their previous treatments, and relapse remains a serious problem as the T cells die off over time. Previous work has demonstrated using a nanoparticle that mimics the natural stimulants of T cells to cause the best quality cells to rapidly reproduce for long periods of time, allowing for more consistent production and increased longevity as a safeguard against relapse. This project intends to ensure that these stimulated cells maintain those traits in addition to their ability to kill targets by culturing them in the natural signals IL-2, IL-7, and IL-15. Although the momentum provided by the stimulation and their own proteins lasts extensively, we observe that the survival signals, particularly IL-2, show promise in promoting long-term expansion beyond what has previously been recorded. Future research is needed to confirm that the stimulated CAR T cells preserve their ability to efficiently kill tumor cells.

High-Throughput Zebrafish Activity Analysis: A Scalable Tool for Reproducible Research

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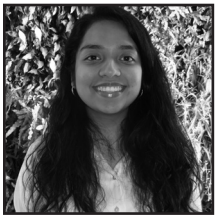
Primary mitochondrial diseases (PMD) are rare genetic disorders that impair the cell's ability to produce energy, affecting high-demand organs like the brain, heart, and muscles. These diseases remain difficult to treat due to their heterogeneity and our limited understanding of the mechanisms underlying symptoms, like exercise intolerance. To investigate these mechanisms, researchers use zebrafish, a common model organism with genetic similarity to humans, amenability to genetic manipulation, and measurable behavioral responses. For PMD, zebrafish swim activity is a proxy for the exercise intolerance and muscle fatigue experienced by patients. The Zebrabox is a common piece of lab equipment that gives consistent measures of zebrafish swim activity. However, existing methods for analyzing this activity are not standardized, limiting accessibility across the research community. This project developed an interactive web application to analyze Zebrabox results, using R Shiny to create dynamic, user-friendly data visualization modules. The tool will allow researchers to more easily identify trends in behavior, interpret experimental results, and advance the discovery of treatments for mitochondrial diseases.



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Developing an Immunomodulatory Scaffold for Diabetc Foot Ulcer Healing

Glucose monitoring for diabetes has continued to advance, but the same cannot be said for the treatment of diabetic complications such as diabetic foot ulcers (DFUs). DFUs are a type of chronic wound that is as serious as it is common among patients with diabetes. In 80% of amputation cases among this population, DFUs are a precursor. DFUs are often hard to detect due to neuropathy, nerve damage, allowing them to grow larger and get infected easily. While surgical debridement is a common treatment for DFUs, it often is only part of a multi-pronged approach that is costly, invasive, and inconsistent depending on the physician. This study sought to create a biomaterial that was cost-effective, nonsurgical, biodegradable, with a dependable and specific release profile. We studied the potency and duration of the release from the scaffold and its degradation over time to create a release profile. The methods of production for the scaffold were adjusted to ensure the preservation of its porous structure to avoid interfering with angiogenesis. Further testing is needed to examine the scaffold's effect on living cells and consequently changes in the wound environment over time.

Dragon Heart 8: The Next Iteration of Blood Pumps for Pediatric Patients with Heart Failure

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Giselle Matlis (STAR 2018)
Co-Mentor

Pediatric heart failure (HF) is a global health crisis with hundreds of thousands suffering annually. The standard of care for pediatric HF is transplantation; however, wait periods and donor-recipient size matching are extensive and complex. Thus, alternative cardiovascular support is required. Blood pumps have demonstrated some success for pediatric patients and have been employed as a bridge-to-transplant. The unique, fragile anatomy of children necessitates patient-specific pumps, of which very few exist. To address this unmet clinical need, we have innovated the Dragon Heart (DH), a pediatric blood pump technology, combining two pumps into one device. The DH is compact in size and leverages cutting-edge, magnetic levitation for rotational operation. Here, we designed the next generation outer pump of the DH. We utilized a Taguchi Design Optimization process and state-of-the-art modeling strategy in the analysis of 9 pump designs. These new designs produced target pressure rises; safe, lower levels of blood cell trauma; and a substantial 40% size reduction. This research provides a strong foundation in support of our translational goal of developing an innovative, safe and effective, new blood pump for pediatric HF.

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Dr. Valerie Klein
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Education

Who's Ready for Kindergarten?: A Case Study

Over 180 years ago, Friedrich Fröbel imagined kindergarten as a "Children's Garden" centered on play, creativity, and socialization as foundations for learning. Today, U.S. readiness standards often emphasize early literacy and numeracy, crowding out social and emotional skills kids develop through unstructured play. This shift risks weakening the "hidden curriculum"—the unspoken values, social norms, and self-regulation skills children acquire through interaction and exploration (Alsubaie, 2015). My research examines the tension between these two readiness frameworks, exploring how a return to intentional, play-based models might better prepare children for holistic success. Using Drexel's Kindergarten 5-week Bridge Program as a case study, I will analyze how structured play, social interaction, and family engagement can address the disconnect between current standards and developmental needs. Grounded in bioecological systems theory and the Action for Early Learning "High Five" framework, K-Bridge acclimates children to school routines, builds relationships, and dedicates over an hour daily to play-based exploration. This study will display how readiness standards can honor both academic preparation and the hidden curriculum.

FRANCIS VELAY FELLOWS

The 2025 STAR Scholars cohort includes our tenth cohort of Frances Velay Fellows, thanks to the generous support of the Panaphil Foundation. This year's cohort of 12 fellows are participating in the full STAR experience, including faculty-mentored research, while also having the opportunity to engage with each other in weekly meetings throughout the summer, some of which included guest mentors. Through the program, we provide participants with the structure and time to reflect on their experiences in STEM, help them build identities as research scientists, and introduce them to a variety of individuals who can support and encourage them in their current and future goals, including advanced pursuit of additional STEM degrees.

The Frances Velay Fellowships have been created in the memory of Frances Velay, a remarkable scientist, artist, musician, and citizen, to assist undergraduate women in the Greater Philadelphia area increase their opportunities to pursue science careers. This opportunity is provided to support individual research efforts in the hope that the Fellowship recipients will embody the spirit and determination Frances Velay brought to her work and life.

This program is jointly managed by the Center for Advancement of STEM Teaching and Learning Excellence (CASTLE) and Undergraduate Research & Enrichment Programs. We would like to thank the Panaphil Foundation for their generous support of undergraduate research and women in STEM, as well as the faculty mentors, graduate students, and industry professionals who come together to support these exceptional women.

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Center for the
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STEM Teaching and
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Undergraduate Research
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The STAR Scholars Program helps shape these students' academic and profesional futures for years to come, and it would not be possible without your participation.

We applaud and thank you.


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